REFRIGERATION AND AIR CONDITIONING TECHNICIAN

NSQF LEVEL - 4

2nd Year

TRADE PRACTICAL

SECTOR : CAPITAL GOODS & MANUFACTURING

(As per revised syllabus July 2022 - 1200Hrs)

Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA

NATIONAL INSTRUCTIONAL
MEDIA INSTITUTE, CHENNAI

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

Sector : **Capital Goods and Manufacturing**

Duration : **2 Year**

Trade : **R&ACT - 2nd year - Trade Practical - NSQF Level - 4 (Revised 2022)**

Developed & Printed by

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First Edition : October 2023 Copies : 1000

Rs. 365/-

FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Media Development Committee members of various stakeholders viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **R&ACT 2nd Year Trade Practical** in **CG & M Sector** under **Yearly Pattern.** The NSQF Level - 4 (Revised 2022) Trade Practical will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 4 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 4 (Revised 2022) the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these Instructional Media Packages IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Director General, Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

ATUL KUMAR TIWARI, ***I.A.S***
Secretary
Ministry of Skill Development & Entrepreneurship,
Government of India.

October 2023
New Delhi - 110 001

PREFACE

The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of the Federal Republic of Germany. The prime objective of this institute is to develop and provide instructional materials for various trades as per the prescribed syllabi under the Craftsman and Apprenticeship Training Schemes.

The instructional materials are created keeping in mind, the main objective of Vocational Training under NCVT/NAC in India, which is to help an individual to master skills to do a job. The instructional materials are generated in the form of Instructional Media Packages (IMPs). An IMP consists of Theory book, Practical book, Test and Assignment book, Instructor Guide, Audio Visual Aid (Wall charts and Transparencies) and other support materials.

The trade practical book consists of series of exercises to be completed by the trainees in the workshop. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered. The trade theory book provides related theoretical knowledge required to enable the trainee to do a job. The test and assignments will enable the instructor to give assignments for the evaluation of the performance of a trainee. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also help him to assess the trainee's understanding. The instructor guide enables the instructor to plan his schedule of instruction, plan the raw material requirements, day to day lessons and demonstrations.

In order to perform the skills in a productive manner instructional videos are embedded in QR code of the exercise in this instructional material so as to integrate the skill learning with the procedural practical steps given in the exercise. The instructional videos will improve the quality of standard on practical training and will motivate the trainees to focus and perform the skill seamlessly.

IMPs also deals with the complex skills required to be developed for effective team work. Necessary care has also been taken to include important skill areas of allied trades as prescribed in the syllabus.

The availability of a complete Instructional Media Package in an institute helps both the trainer and management to impart effective training.

The IMPs are the outcome of collective efforts of the staff members of NIMI and the members of the Media Development Committees specially drawn from Public and Private sector industries, various training institutes under the Directorate General of Training (DGT), Government and Private ITIs.

NIMI would like to take this opportunity to convey sincere thanks to the Directors of Employment & Training of various State Governments, Training Departments of Industries both in the Public and Private sectors, Officers of DGT and DGT field institutes, proof readers, individual media developers and coordinators, but for whose active support NIMI would not have been able to bring out this materials.

Chennai - 600 032 **EXECUTIVE DIRECTOR**

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisations to bring out this Instructional Material **(Trade Practical)** for the trade of **R&ACT 2nd Year NSQF Level - 4 (Revised 2022)** under **Capital Goods & Manufacturing** Sector for ITIs.

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Shri. V. Gopalakrishnan	-	Manager, NIMI, Chennai - 32.

NIMI records its appreciation of the Data Entry, CAD, DTP Operators for their excellent and devoted services in the process of development of this Instructional Material.

NIMI also acknowledges with thanks, the invaluable efforts rendered by all other staff who have contributed for the development of this Instructional Material.

NIMI is grateful to all others who have directly or indirectly helped in developing this IMP.

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intended to be used in practical workshop. It consists of a series of practical exercises to be completed by the trainees during the course. These exercises are designed to ensure that all the skills in compliance with NSQF Level - 4 (Revised 2022) syllabus are covered.

The manual is divided into Ten modules

Module 1	**Commercial Compressor**
Module 2	**Water Cooled Condenser with Cooling Tower**
Module 3	**Expansion Valve**
Module 4	**Evaporator & Chillers**
Module 5	**Cooler & Freezer**
Module 6	**Applications of Commercial Refrigeration**
Module 7	**HVAC Systems**
Module 8	**Central Industrial Air Conditioning**
Module 9	**Mobile Air Conditioning**
Module 10	**Evaporator & Chillers**

The skill training in the shop floor is planned through a series of practical exercises centered around some practical project. However, there are few instances where the individual exercise does not form a part of project.

While developing the practical manual, a sincere effort was made to prepare each exercise which will be easy to understand and carry out even by below average trainee. However the development team accept that there is a scope for further improvement. NIMI looks forward to the suggestions from the experienced training faculty for improving the manual.

TRADE THEORY

The manual of trade theory consists of theoretical information for the Course of the **R&ACT 2nd Year NSQF Level - 4 (Revised 2022)** in **CG & M**. The contents are sequenced according to the practical exercise contained in NSQF Level - 4 (Revised 2022) syllabus on Trade Theory attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This correlation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

The trade theory has to be taught and learnt along with the corresponding exercise contained in the manual on trade practical. The indications about the corresponding practical exercises are given in every sheet of this manual.

It will be preferable to teach/learn trade theory connected to each exercise at least one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not for the purpose of self-learning and should be considered as supplementary to class room instruction.

CONTENTS

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

S.No	Learning Outcome	Ref. Ex.No.
1	Carry out servicing, dismantling, checking different parts of different types of commercial compressor, re-placing worn out parts, Check lubrication system. Assemble & check performance. NOS- ELE/N3140	2.1.99 - 2.1.114
2	Perform servicing of different types of water-cooled condenser. NOS- ELE/N3140	2.2.115 - 2.2.118
3	Perform servicing and performance test of Cooling tower NOS- ELE/N3141	2.2.119
4	Conduct Servicing, backwash & re-generate Water treatment plant of circulating water. NOS CSC/N9415	2.2.120
5	Perform Fitting of expansion valve, adjustment of refrigerant flow according to heat load. NOS- ELE/N3140	2.3.121 - 2.3.122
6	Perform servicing of evaporator & chillers. NOS- ELE/N3140	2.4.123 - 2.4.128
7	Carry out servicing and retrofit of Water cooler and dispenser. NOS CSC/N9416	2.5.129 - 2.5.132
8	Service, retrofit of visible cooler and bottle cooler and test performance. NOS CSC/N9417	2.5.133 - 2.5.137
9	Conduct servicing of deep freezer and test performance. NOS CSC/N9418	2.5.138 - 2.5.141
10	Install, service, repair, gas charging and testing performance of Ice Cube machine. NOS CSC/N9419	2.6.142
11	Repair, servicing & retrofit of ice candy plant. NOS CSC/N9420	2.6.143 - 2.6.144
12	Perform servicing of Ice plant and evaporative condenser. NOS CSC/N9421	2.6.145 - 2.6.146
13	Perform Servicing and preventive maintenance of walk in cooler & cold storage. NOS CSC/N9422	2.6.147 - 2.6.153
14	Study psychrometric chart and measure psychrometric properties using psychrometric, anemometer i.e. DBT, WBT, RH, air flow etc. NOS- ELE/N3140	2.7.154 - 2.7.156
15	Perform servicing of motor and blowers used in different air conditioning system. NOS- ELE/N3141	2.7.157
16	Construct, install, pack thermal and acoustic insulation of different air ducts. NOS- ELE/N3141	2.7.158 - 2.7.160
17	Perform servicing and maintenance of different types of air filters. NOS- ELE/N3141	2.7.161
18	Perform servicing, installation, fault diagnosis and remedial measures on Package AC with Air cooled condenser. NOS CSC/N9423	2.8.162 - 2.8.163
19	Carry out Servicing, installation, fault diagnosis and remedial measures in Package A.C. with water cooled condenser. NOS- ELE/N3140	2.8.164 - 2.8.166
20	Identify the various components of central AC test electrical components and make wiring. Servicing of A.H.U, damper, check air flow, De-scaling of condenser and CT servicing. NOS- ELE/N3141	2.8.167 - 2.8.170
21	Pump down the system, top up oil and gas and check temperature and pressure. NOS- ELE/N3140	2.8.171 - 2.8.172
22	Identify components of DX system. Test components, make wiring of DX system. Test leak and evacuate, gas charge the system and check the performance. Maintenance, trouble shoot and operate the plant. NOS- ELE/N3140	2.8.173 - 2.8.174

23	**Identify the different parts of VRF/VRV system, check and service VRF/VRV system. NOS- ELE/N3141**	**2.8.175 - 2.8.177**
24	**Identify different parts of indirect or chillers system. Check components and make wiring, leak test, evacuate and gas charge/ top up. Servicing the plant and trouble shoot. NOS- ELE/N3141**	**2.8.178 - 2.8.179**
25	**Identify chilled water pipe line. Servicing of dampers, FCU and water control valves. NOS- ELE/N3141**	**2.8.180 - 2.8.181**
26	**Troubles shoot both Central A.C. plant DX and indirect system. Check different control system, installation of other major components, servicing of all parts including cooling tower and water treatment plant. NOS- ELE/N3141**	**2.8.182 - 2.8.184**
27	**Perform servicing of car AC. Fault diagnosis & remedial measures. NOS- ELE/N3141**	**2.9.185 - 2.9.188**
28	**Perform Servicing, fault diagnosis, repair and maintenance of mobile A.C. leak test, evacuation, gas charging, check magnetic clutch and make wiring. Test performance after start. NOS- ELE/N3141**	**2.9.189 - 2.9.190**
29	**Perform preventive maintenance of different plants. Maintain log book based on daily operation. NOS- ELE/N3141**	**2.10.191 - 2.10.192**

SYLLABUS

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 95 Hrs.; Professional Knowledge 20 Hrs.	Carry out Servicing, dismantling, checking different parts of different types of commercial compressor, re- placing worn out parts, Check lubrication system. Assemble & check performance. NOS- ELE/N3140	99.Familiarization with commercial type reciprocating compressor and centrifugal compressor. (04 hrs.) 100.Dismantling and checking of compressor & accessories. (10 hrs.) 101.Check and service valve plate and piston assembly. (05 hrs.) 102.Lapping valve plate, and refit. (05 hrs.) 103.Check belt tension	**COMMERCIAL COMPRESSOR** **(Fixed & Variable)** Function, types, Construction & working, applications of compressors used in commercial refrigeration. Volumetric efficiency, Capacity control. (05 hrs.)
		104.Check and test lubricating system. (05hrs.) 105.Servicing of filter and oil pump. (08 hrs.) 106.Cutting gasket. (04 hrs.)	Compressor lubricant oil, types, properties, types of lubrication methods such as splash, forced feed. Study the Construction and working principle of different commercial compressor, open type, (Reciprocating, centrifugal (05 hrs.)
		107.Assemble compressor and Test overall efficiency. (07 hrs.) 108.Star & Delta connection on a three-phase motor and show line voltage, line current, phase voltage and phase current insulation test,and continuity. (10 hrs.)	Screw compressor. Star and Delta connection and their comparison. Production of rotating magnetic field by three phase AC supply. Working principle of three phase induction motor. Terms such as torque, slip, rotor frequency and

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
		109. Identify the terminals of a Squirrel cage induction motor. (06 hrs.) 110. Start the motor through DOL starter and measure starting current, running current and show changing of DOR. (06 hrs.) 111. Start the motor through Star Delta or Auto transformer starter and measure starting current, running current and show changing of DOR. (06 hrs.) 112. Familiarise with Slip-ring induction motor and identify it's terminals. (04 hrs.) 113. Start the Slip-ring induction motor through Rotor resistance starter and measure starting current, running current and show changing of DOR. (03 hrs.) 114. Rectify fault through insulation test, continuity, open circuit and short circuit test. (8 Hrs)	their relation. Construction of squirrel cage induction motor. Importance of phase sequence. Construction of slip ring induction motor Comparison between SCIM and SRIM. Three phase motor starters such as DOL starter, Star – Delta starter, Auto transformer starter and Rotor resistance starter. Common faults, causes and remedies in three phase AC motors. (10 hrs.)
Professional Skill 50 Hrs.; Professional Knowledge 15Hrs.	Perform Servicing of different types of water-cooled condenser. NOS-ELE/N3140	115Servicing of water-cooled condenser and receiver. (13 hrs..) 116Testing its performance by inlet and outlet pressure and temperature. (13 hrs.) 117. De-scaling by diluted HCl to increase efficiency. (12 hrs.)	**WATERCOOLED CONDENSER** Study the water-cooled Condenser, its type and capacity, construction and working, de scaling, application. (08 hrs.)
		118. Pump down the gas for necessary servicing and repairing. (12 hrs.)	Evaporative condenser, function, construction and application. Liquid receiver, function. Drier, types and application. (07 hrs.)
Professional Skill 15 Hrs.; Professional Knowledge 06 Hrs.	Perform servicing of and performance test of Cooling tower. NOS-ELE/N3141	119. Servicing of natural draft, forced draft and induced draft cooling tower. (15 hrs.)	**COOLING TOWER** Cooling tower, types, Construction, capacity advantage & disadvantages of different types of cooling tower. Efficiency, approach and Cooling tower range. (06 hrs.)
Professional Skill 10 Hrs.; Professional Knowledge 06 Hrs.	Conduct servicing, & re-generate water treatment plant of circulating water. NOS CSC/N9415	120. Dismantle and Assemble water circulating pump. (10 hrs.)	**WATERTREATMENT** Causes for water contamination and water treatment. (6 Hrs)
Professional Skill 20 Hrs.; Professional Knowledge 11 Hrs.	Perform fitting of expansion valve, Adjustment of refrigerant flow according to heat load. NOS- ELE/N3140	121. Familiarize with thermostatic and Electronic expansion valve.(10 hrs.)	**EXPANSION VALVE** Types and function, construction, working principle, & their advantage& disadvantages. Thermostatic Expansion Valves

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
			(TXV), Automatic Expansion Valves (AXV), Float valves, fixed and modulating orifice controls & electronic Expansion Valves, LMC (level master control).(07 hrs.)
		122. Identify automatic expansion valve.(10 hrs.)	Selection of Expansion valves and capillaries for various Refrigeration and Air-conditioning applications. (04 hrs.)
Professional Skill 60 Hrs.; Professional Knowledge 13 Hrs.	Perform servicing of evaporator & chillers. NOS- ELE/N3140	123. Identify extended surface forced air-cooled evaporators.(05 hrs.) 124. Service air cooled evaporator by blower.(15 hrs.) 125. Service water cooled or brine cooled chiller.(15 hrs.) 126. Check de-frosting system and anti-freeze thermostat.(10 hrs.) 127. Oil removing from coil.(05 hrs.)	**EVAPORATOR** Function, types, Plate & Tube forced air DX evaporators. Types of Defrost system. Water/ Brine chillers. Types of brine used as secondary refrigerant. Accumulator, its function. (06 hrs.)
		128. Servicing of liquid suction heat exchanger used in central plant. (10 hrs.)	Liquid-suction-liquid Heat-exchanger, their function, construction, application & advantages. Study of Accumulator and Oil separator. (07 hrs.)
Professional Skill 40 Hrs.; Professional Knowledge 05 Hrs.	Carry out Servicing and retrofit of Water cooler and dispenser. NOS CSC/N9416	129. Identify parts, control, electric circuit, accessories of storage type water cooler and Bubble type water dispenser.(03 hrs.) 130. Trouble shoot of commonly faced problems like condenser fan motor failure, corrosion etc. (10 hrs.) 131. Install gauge manifold, Leak test and refrigerant charging after evacuation. (15 hrs.) 132. Installation, servicing and maintenance of water cooler and dispensers. (12 hrs.)	**WATER COOLER & WATER DISPENSER** Study the refrigeration cycle of storage type water cooler and dispenser types. Construction & working, Capacity & applications. Study the electrical and mechanical components of storage type water cooler. (05 hrs.)
Professional Skill 45 Hrs.; Professional Knowledge 05 Hrs.	Service, retrofit of visible cooler and bottle cooler and test performance. NOS CSC/N9417	133. Checking and servicing of visible cooler and bottle cooler and its parts.(10 hrs.) 134. Preventive maintenance and trouble shooting (05 hrs.) 135. Evacuation, flushing with dry nitrogen, Retrofit the machine with HFC 134a, R- 600a, R-290.(10 hrs.) 136. Check wiring circuit, test components & replace.(10 hrs.) 137. Install and Test performance of the machine. (10 hrs.)	**VISIBLE COOLER AND BOTTLE COOLER** Visible cooler & bottle coolers. Description, construction & working, with HFC-134a and hydrocarbons, safety especially for flammable refrigerants, maintenance, testing of mechanical and electrical components including sealed electrical components fitted in appliances using flammable refrigerants. (05 hrs.)

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 35 Hrs.; Professional Knowledge 05 Hrs.	Conduct servicing of deep freezer and test performance. NOS CSC/ N9418	138Checking and servicing of horizontal and vertical deep freezer / display cabinet and their different parts. (10 hrs.) 139Preventive maintenance and trouble shooting.(05 hrs.) 140Check wiring circuit, test and replace defective components. (10 hrs.) 141Install and test performance. (10 hrs.)	**DEEP FREEZER / DISPLAY CABINET** Description, Construction, working, specifications, function, care and maintenance, faults and remedies. (05 hrs.)
Professional Skill 15 Hrs.; Professional Knowledge 05 Hrs.	Install, service, repair, gas charging and testing performance of Ice Cube machine. NOS CSC/N9419	142. Checking and servicing of ice cube machine and its different components. (15hrs.)	**ICE CUBE MACHINE-** Description, Construction, working, reverse cycle functioning & Circuit diagram, installation method. **SOFTY MACHINE -** Description, Construction and function. (05 hrs.)
Professional Skill 20 Hrs.; Professional Knowledge 05 Hrs.	Repair, servicing & retrofit of ice candy plant. NOS CSC/N9420	143. Identify different parts, controls and accessories used in ice-candy plant. (10 hrs.) 144. Prepare brine solution, function of agitator and temperature maintained in brine. (10 hrs.)	**ICE CANDY PLANT-** Function, construction, working principle, Circuit diagram, capacity& types of compressor used. Brine composition to maintain required temperature. Operation, maintenance, retrofit. (05 hrs.)
Professional Skill 25 Hrs.; Professional Knowledge 06 Hrs.	Perform servicing of Ice plant and evaporative condenser. NOS CSC/ N9421	145. Identify parts, accessories and controls of ice plant. (10 hrs.) 146. Check, service and operate ice plant (15 hrs.)	**ICE PLANT-** Details about components of Ice plant their functioning, (06 hrs.)
Professional Skill 55 Hrs.; Professional Knowledge 12 Hrs.	Perform Servicing and preventive maintenance of walk in cooler & cold storage. NOS CSC/ N9422	147. Identify parts, accessories, controls and operation of walk in cooler and reach in cabinet. (10 hrs.) 148. Preventive maintenance, trouble shooting and servicing of components. (10 hrs.)	**WALK IN COOLER & REACH IN CABINET** Details about components, their functioning, working principle, Circuit diagram, capacity & types. Care and maintenance. (03 hrs.)
		149Identify parts, controls and accessories of Cold storage plant. (05 hrs.) 150Service and operation of cold storage plant. (10 hrs.) 151Check the refrigeration system of the cold storage plant.(05hrs.) 152Measure pressure and temperature.(05hrs.) 153Evacuation by two stage rotary vacuum pumps and gas charging. (10hrs.)	**COLD STORAGE** Study of cold storage plant, parts, Construction, applications, controls & electrical diagram used in cold storage plant. Food preservation spoiling agents-controlling of spoiling agents, preservation by refrigeration system, maintaining temperature in different places. Types of cold storage and its details. (05 hrs.)

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
			capacity and specification. Use of vibration eliminator and shock absorber, Study the lay out . Cold storage plant operation, its common trouble & remedies. Deep freezing, freezing tunnel, blast freezer its function and working, its application.(04 hrs.)
Professional Skill 50 Hrs.; Professional Knowledge 11 Hrs.	Study psychrometric chart and measure psychrometric properties using psychrometric, anemometer i.e. DBT, WBT, RH, air flow etc. NOS- ELE/N3140	154 Find out DBT, WBT, RH & other properties by using psychrometric chart. (15 hrs.) 155 Use psychrometer for finding DBT and WBT.. (15 hrs.)	**HVAC (Plant) –** Introduction to HVAC, Fundamentals of Central Air Conditioning / HVAC plant, requirements of comfort A.C, study of psychometric terms, DBT, WBT, RH, enthalpy, dew point, and specific humidity. (05 hrs.)
		156 Use Anemometers for measuring air flow. (20 hrs.)	Types of Central air conditioning (Direct and indirect system) Construction, working, components, faults, care and maintenance. (06hrs.)
Professional Skill 20 Hrs.; Professional Knowledge (07 hrs)	Perform servicing of motor and blowers used in different air conditioning system. NOS- ELE/N3141	157 Service of fans and blowers used in air-conditioning system. (20 hrs.)	Description of blowers& fans, function and types, static and velocity pressure measurements. (07 hrs.)
Professional Skill 30 Hrs.; Professional Knowledge 05 Hrs.	Construct, install, pack thermal and acoustic insulation of different air ducts. NOS- ELE/ N3141 Perform servicing and maintenance of different types of air filters. NOS-ELE/N3141	158. Construct Ducts as per duct layout drawing. (10 hrs.) 159. Insulate Ducts. (05hrs.) 160. Service and maintain different filters. (10 hrs.) 161. Placing of filters. (05 hrs.)	**DUCT** Function, types, materials, duct designing, duct insulation, properties of insulating **AIR FILTERS** Function of air filters, types, construction, maintenance, effect of chocked Air filter, (05 hrs.)
Professional Skill 35 Hrs.; Professional Knowledge 6 Hrs.	Perform servicing, installation, fault diagnosis and remedial measures on Package AC with Air cooled condenser. NOS CSC/ N9423	162. Identify various components of Package AC (Air Cooled Condenser). (15 hrs.) 163. Check electrical circuit of Package AC (Air Cooled Condensers). (20 hrs.)	**PACKAGE AC (with Air Cooled Condenser)** Study the Package AC (with Air Cooled Condensers),its construction and working principle, types, trouble shooting. (6hrs.)
Professional Skill 25 Hrs.; Professional Knowledge 15 Hrs.	Carry out servicing, installation, fault diagnosis and remedial measures in Package A.C. with water cooled condenser. NOS- ELE/ N3140	164. Identify various components of package AC, (Water cooled condenser). (06hrs.) 165. Identify various components of split package AC. (07 hrs.) 166. Electrical circuit of split package AC. (12 hrs.)	**PACKAGE A.C WITH WATER COOLED CONDENSER** Study Package AC, construction and working principle, Duct system, AHU. Care and maintenance. (15 hrs.)

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 30 Hrs.; Professional Knowledge 07 Hrs.	Identify various components of central AC, test electrical components and make wiring. Servicing of A.H.U, damper, check air flow, De-scaling of condenser and CT servicing. NOS- ELE/ N3141	167. Identify various components of central AC plant.(Direct) (04 hrs.) 168. Electrical circuit of central AC plant. (10 hrs.) 169. Servicing AHU including fire dampers. (06hrs.) 170. Checking airflow, damper, temperature and pressure. (10 hrs.)	**CENTRAL/ INDUSTRIAL AIRCONDITIONING.** Construction and working principle, types, maintenance of Industrial Air-conditioning plant. Humidification and dehumidification methods. Description of AHU and FCU (07 hrs.)
Professional Skill 10 Hrs.; Professional Knowledge 07 Hrs.	Pump down the system, top up oil and gas and check temperature and pressure. NOS- ELE/ N3140	171. Pump down gas from central AC plant. (05 hrs.) 172. Check temperature and pressure control. (05 hrs.)	Temperature and pressure controls used in AC plant, its construction, working, safety devices, piping lines. (07 hrs.)
Professional Skill 20 Hrs.; Professional Knowledge 05 Hrs.	Identify components of DX system. Test components, make wiring of dx system. Test leak and evacuate, gas charge the system and check the performance. Maintenance, trouble shoot and operate the plant. NOS- ELE/N3140	173. Identify various components of direct expansion type central AC plants. (10 hrs.) 174. Electrical circuit of direct expansion type central AC plants. (10 hrs.)	**DIRECT EXPANSION SYSTEM** Study Direct expansion system. Operation & Preventive Maintenance Schedule of central AC plant. Maintain log book for daily operation. (05 hrs.)
Professional Skill 20 Hrs.; Professional Knowledge 6 Hrs.	Identify the different part of VRF/VRV system, check and service VRF/ VRV system. NOS-ELE/N3141	175. Identify VRF / VRV system. (05 hrs.) 176. Check and service VRF / VRV system. (10 hrs.) 177. Identify error code. (05 hrs.)	VRF / VRV system – description and function of different parts. Details of piping have and controls system, Common reason for error code, types of ODU and IDU. (6hrs.)
Professional Skill 15 Hrs.; Professional Knowledge 07 Hrs.	Identify different part of indirect or chiller system. Check components and make wiring, leak test, evacuate and gas charge/ top up. Servicing the plant and trouble shoot. NOS-ELE/N3141	178. Service various components of indirect expansion type central AC plants. (05 hrs.) 179. Check electrical circuit of indirect expansion type central AC plants. (10 hrs.)	**INDIRECT/CHILLER SYSTEM** Study central station AHU and FCU, Air washers used in chilled water system, understanding lay out, modulating valves for temperature control. Expansion valves & other related control – description and function. (07 hrs.)
Professional Skill 20 Hrs.; Professional Knowledge 05 Hrs.	Identify chilled water pipe line. Servicing of dampers, FCU and water control valves. NOS- ELE/N3141	180. Insulate chilled water piping's. (08 hrs.) 181. Servicing of FCU and water control valves. (12 hrs.)	Study of Humidification & De-humidification. Humidifiers & De-humidifier's. Humidity control. Use of hygrometer. (05 hrs.)
Professional Skill 20 Hrs.; Professional Knowledge 10 Hrs.	Troubles shoot of both central A.C. plant Dx and indirect system. Check different control system installation of other	182. Check Vibration eliminator and water proofing insulation. (5 hrs.) 183. Check different controls used in central AC system. (10 hrs.)	Construction and study of commercial A.C plant, package chillers, screw chillers, reciprocating chillers. (5 hrs.)

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
	major components, servicing of all parts including cooling tower and water treatment plant. NOS- ELE/N3141	184. Trouble shooting of central AC. (5hrs.)	Controls used in AC system, Electromechanical, pneumatic and electronic. Detail study of heat load calculation for commercial and industrial buildings. (5 hrs.)
Professional Skill 35 Hrs.; Professional Knowledge 10 Hrs.	Perform servicing of car AC. Fault diagnosis & remedial measures. NOS- ELE/N3141	185. Identify various mechanical and electrical components used in car AC. (03 hrs.) 186. Testing of system components & fault finding (08 hrs.) 187. Install gauge manifold to check suction and discharge pressure in charging time and running time. (04 hrs.) 188. Leak testing using dry nitrogen, evacuation and gas charging (HFC-134a, HFO- 1234yf and blends of HFCs and HFOs). (04 hrs.)	**CAR AIR CONDITIONING** Study various components and cycle of Car AC, electrical circuits, Study of good service practice, trouble shooting, Magnetic clutch operation, free movement of flywheel (nonfunctioning of clutch),care and maintenance. (05 hrs..)
	Perform Servicing, fault diagnosis, repair and maintenance of mobile A.C. leak test, evacuation, gas charging, check magnetic clutch and make wiring. Test performance after start. NOS- ELE/N3141	189.Installation and trouble shooting (08 hrs.) 190.Testing magnetic clutch, compressor overhauling, condenser cleaning and add refrigerant Regular maintenance (08 hrs.)	**MOBILE AC (Bus, train)** Construction and working of bus AC. Construction & working of train AC and its operation. Trouble shooting in train A.C. (5 hrs.)
Professional Skill 25 Hrs.; Professional Knowledge 05 Hrs.	Perform preventive maintenance of different plants. Maintain log book based on daily operation. NOS- ELE/ N3141	191Study/execute repair of different commercial units at site. (13 hrs.) 192Study/execute preventive maintenance of different commercial units at site. (12 hrs.)	Planning for Preventive maintenance and scheduling of maintenance activities in large AC and Refrigeration plant. (05 hrs.)

QR CODE

Module 1

Ex.No. 2.1.99 Ex.No. 2.1.100 Ex.No. 2.1.101 Ex.No. 2.1.104 Ex.No. 2.1.106 Ex.No. 2.1.107

Module 1

Ex.No. 2.1.108 Ex.No. 2.1.111 Ex.No. 2.1.113

Module 2

Ex.No. 2.2.115 Ex.No. 2.2.115 Ex.No. 2.2.118

Module 3

Ex.No. 2.3.121

Module 4

Ex.No. 2.4.123 Ex.No. 2.4.124 Ex.No. 2.4.127

Module 5

Ex.No. 2.5.131 Ex.No. 2.5.132 Ex.No. 2.5.133 Ex.No. 2.5.136 Ex.No. 2.5.137 Ex.No. 2.5.138

Module 5

Ex.No. 2.5.139 Ex.No. 2.5.141

Module 6

Ex.No. 2.6.147 Ex.No. 2.6.148 Ex.No. 2.6.153

Module 7

Ex.No. 2.7.156

Module 8

Ex.No. 2.8.162 Ex.No. 2.8.164 Ex.No. 2.8.165 Ex.No. 2.8.166 Ex.No. 2.8.170

Module 10

Ex.No. 2.10.191

Familiarization with commercial reciprocating compressor and centrifugal compressor

Objectives: At the end of this exercise you shall be able to
- **identify the parts of commercial reciprocating compressor at installed condition**
- **identify the parts of centrifugal compressor.**

Requirements

Tools/Instruments
- Air blower (1 saw) - 1 No.

Equipment/Machines
- Commercial open type (reciprocating)
- Compressor system - 1 Set.

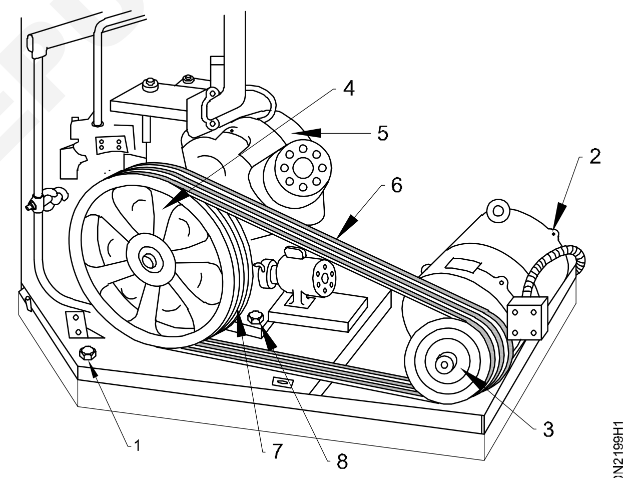
Materials
- Oil can - 1 No.
- Kerosene oil - 2 ltr.
- Banian cloth - 1 Sq.m.
- Lables - as reqd.

PROCEDURE

TASK 1 : **Identify the parts of commercial reciprocating compressor at installed condition**

1 Switch off the mains.
2 Take out kitkat fuse and keep safely in your custody.
3 Close the cover of main switch.
4 Clean the unit with air blower / oil socked cotton waste.
5 Clean with dry cloth.
6 Identify the parts as shown in Fig 1.

Fig 1



COMPRESSOR MOTOR DRIVE SYSTEM

Record sheet

Table 1

Sl. No.	Parts Name
1	
2	
3	
4	
5	
6	
7	
8	

Compressor Table 2	
Make	
Type	
Voltage	
Rated Amps.	

Motor Table 3	
Make Type No load Amps. Full load Amps.	

Table 4	
Total No. of 'V' belts Make Size No. of belts/OK No. of belts/Not OK	

— — — — — — — —

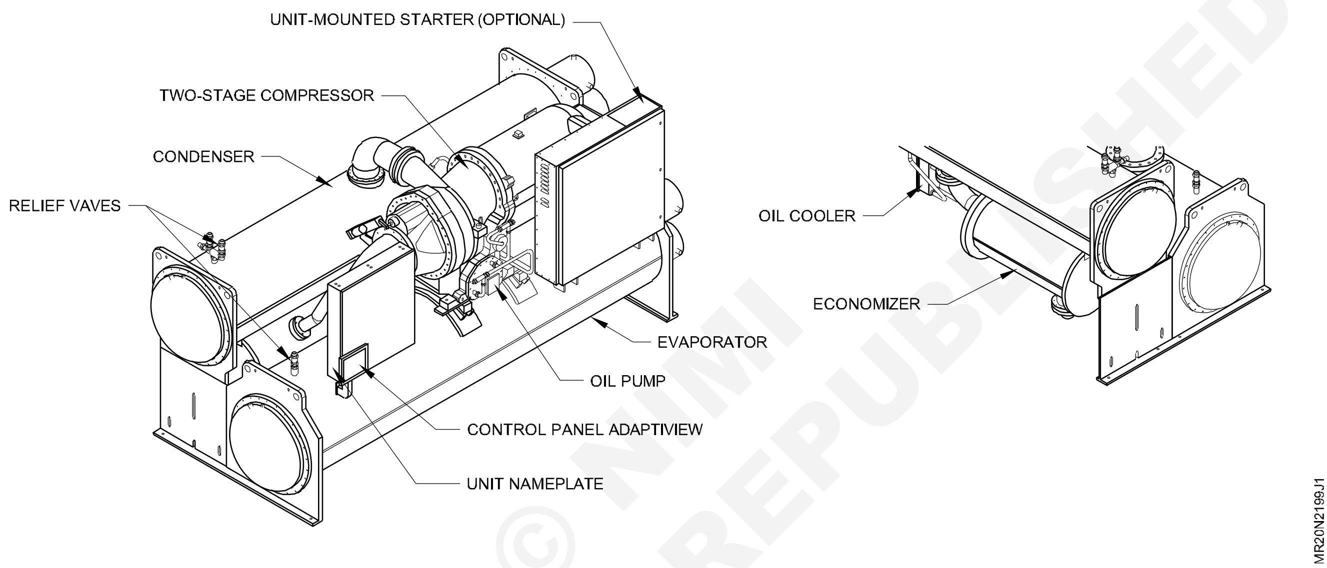
TASK 2 : **Identify the parts of centrifugal compressor**

Repeat the steps 1 to 5 of task 1.

Identify the parts as shown in Fig 1.

Note : Instructors may show the videos / live pictures to the trainees to do this task.

Fig 1



Sl. No	Name of the parts
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

Remarks

Trainees **Instructor**

— — — — — — — —

Dismantle and check compressor and accessories

Objectives: At the end of this exercise you shall be able to
- **pump down the system**
- **isolate the electrical connections, decouple the compressor from motor drive**
- **remove and shift the compressor to work bench**
- **drain the oil and the external service of the compressor**
- **dismantle the compressor.**

Requirements

Tools/Instruments

• Compound gauge, pressure gauge attached to operating panel	- 1 No.
• Ratchet wrench	- 1 No.
• Box spanner set	- 1 Set.
• Double end spanner set	- 1 Set.
• Ring spanner set	- 1 Set.
• Screw driver (10 mm tip length 250 mm)	- 1 No.
• Hammer ball pein (450 g)	- 1 No.
• Internal circlip plier	- 1 No.
• Center punch	- 1 No.
• Mallet	- 1 No.
• Brass flat scraper	- 1 No.
• Valve key	- 1 No.

Equipment/Machines

- Commercial Reciprocating - type Compressor

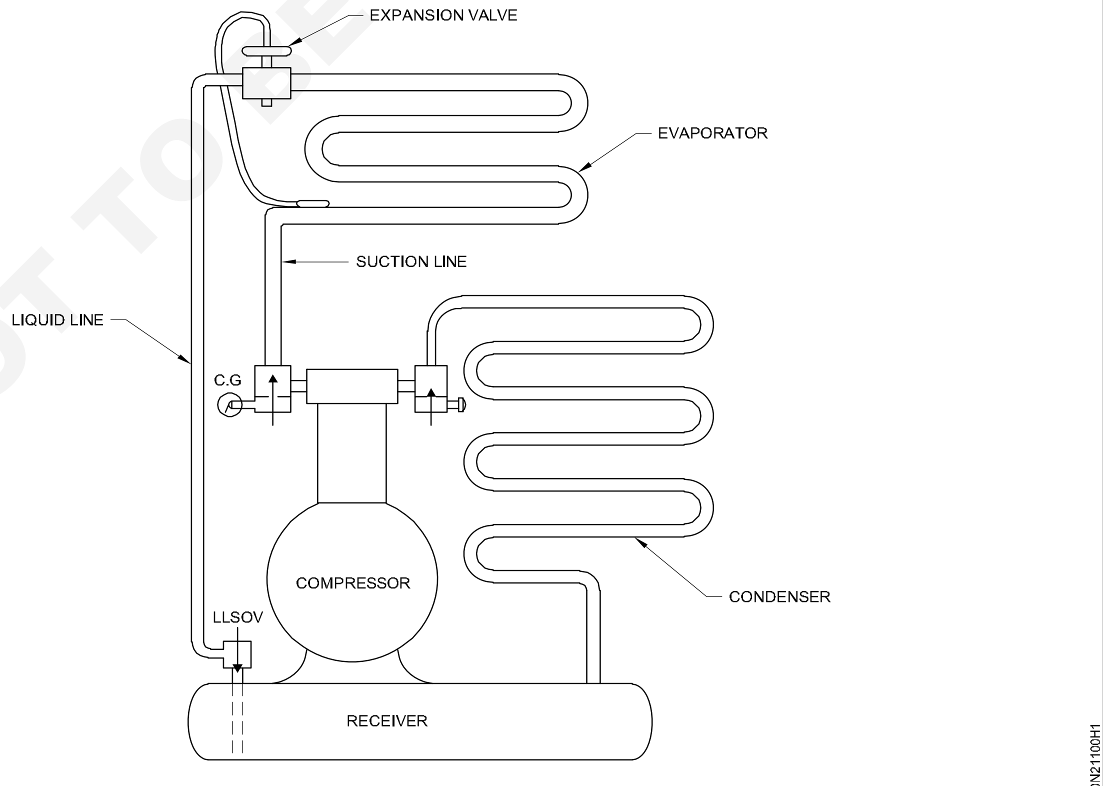
Materials

• Oil can	- 1 No.
• Tray	- 1 No.
• Kerosene oil	- 2 ltr.
• Petrol	- 1 ltr.
• Banian cloth	- 1 Sq.m.
• Polythene covers	- as reqd.
• Labels	- as reqd.
• Trolley	- 1 No.
• Wooden blocks	- as reqd.

PROCEDURE

TASK 1 : **Pump down the system** (Fig 1)

Fig 1



PUMPDOWN REFRIGERANT TO THE RECEIVER

1 Put off the system, if it is running.

2 By pass the electrical connection at the low pressure cut-out switch.

3 Close the (king valve) liquid line shut off valve.

4 Start the compressor and watch the suction valve gauge pressure drops till 0.5 kg/sq.cm.

5 Stop the compressor and close the discharge valve Refer Fig 1 transferring refrigerant to the receiver.

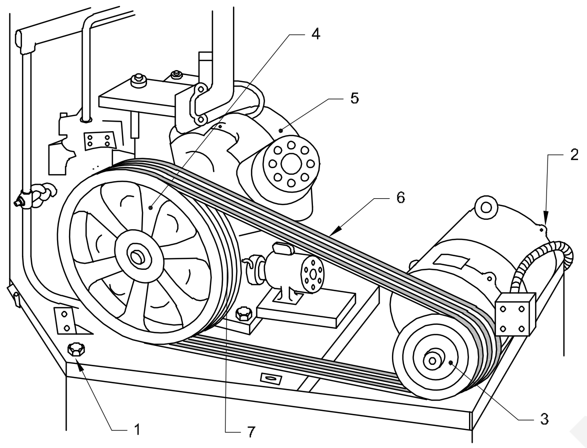
Precaution : Ensure the water flow in the water cooled condenser.

— — — — — — — —

TASK 2 : **Isolate the electrical connections, decouple the compressor from motor drive (Fig 2)**

1 Put off the isolator in the electrical panel, remove and keep the fuse carefully, and remove the safety guard of drive system.

Fig 1



COMPRESSOR MOTOR DRIVE SYSTEM

1. BASE BELT 2. MOTOR
3. MOTOR PULLEY 4. FLYWHEEL
5. COMPRESSOR 6. 'V' BELT
7. BELT GROOVE

2 Remove the pencil heater from the crankcase thermo well, disconnect the electrical connection and label the wires.

3 Record the name plate details of the compressor, and record in the record sheet Table 1 and motor details in Table 2.

Compressor Table 1	
Make	
Type	
Voltage	
Rated Amps.	

Motor Table 2	
Make	
Type	
No load Amps.	
Full load Amps.	

4 Mark the nos. of 'V' belts, slip it one by one giving the leverage by the screw driver, and rotate the motor pulley gently.

5 Start removing belts from outer side of the drive motor pulley slip the belt to the alternate groove, step by step.

Check the belts, if damaged note the size for replace. Record it in Table 3 of the Record sheet.

Table 3	
Total No. of 'V' belts	
Make	
Size	
No.of belts/OK	
No.of belts/Not OK	

— — — — — — — —

TASK 3 : **Remove and shift the compressor to work bench**

1 Loosen the compressor base bolts with suitable ring and double end spanners

2 Keep the trolley near the compressor bed, support the wheels not to move, while shifting the compressor

3 With Instructor's demonstration, the wooden blocks should place on the trolley.

4 Use the iron bars for leverage, lift the compressor from bed and keep it carefully on the wooden block on the trolley. Ensure the compressor seat, well balanced.

5 The solid packings and the shims should remain on each base bolt.

6 Move the trolley slowly to work bench and shift the compressor.

7 Make the compressor to seat on the wooden block, since the weight should not act on the fly wheel.

— — — — — — — —

TASK 4 : **Drain the oil and the external service of the compressor**

1 Remove the shaft's end nut and washer for the fly wheel. Keep a clean tray and remove the wheel by wheel puller (Pulley puller)

2 Remove the woodruff key from the key way, keep all these parts in the tray, label it in order.

3 Drain out the oil from the compressor and measure it. Remarks of the drained oil can be noted in Table 4 of Record sheet.

4 Clean the external part of the shaft, base of the compressor and body with kerosene, use banian cloth.

Table 4

Remarks of the drained oil	
Quantity of the oil	
Colour of the oil	
Condition of the oil	OK/Not OK

— — — — — — — —

TASK 5 : **Dismantle the compressor**

1 Punch mark in the compressor head plate, valve plate and head. Select the correct size box socket and loosen all the bolts 1/4 turn diagonally, repeat till all bolts are fully loose.

2 Keep the bolts in tray, with the use of mallet tap the head and valve plate assembly. Try not to damage the gasket. Label it in order.

3 Punch mark in line the compressor body and seal cover. Loosen the seal cover bolts evenly. Hold the seal cover firmly, so it does not jump out due to spring tension. Keep all removed parts in the polythene cover and pin a label.

4 Mark the crankcase cover and body in line, loosen the crank case cover bolts. Keep the cover bolts and gasket in tray.

5 Mark in line the connecting rod at bearing housing halves, then loosen connecting rod bolts, separate the bearing housing, pull the connecting rod and piston through the cylinder.

6 Dismantle the piston from connecting rod, and the rings from the piston. Use circlip plier and remove the circlip. Tap the piston and remove from the piston. Keep it in order in the tray.

7 Loosen the front cover bolts evenly tap with mallet and remove the cover. Bring the crank shaft out of the crankcase.

8 Remove the suction and delivery valves from the valve plate, loosen the valve reeds holding screws and keep the suction and delivery valve reeds in the tray in order, label it.

9 All the individual parts should be thoroughly cleaned with kerosene and wipe it. Rinse with petrol.

10 Fill up the record sheet, given at the end of the exercise.

11 Get it approved by your instructor.

Record sheet

Date:

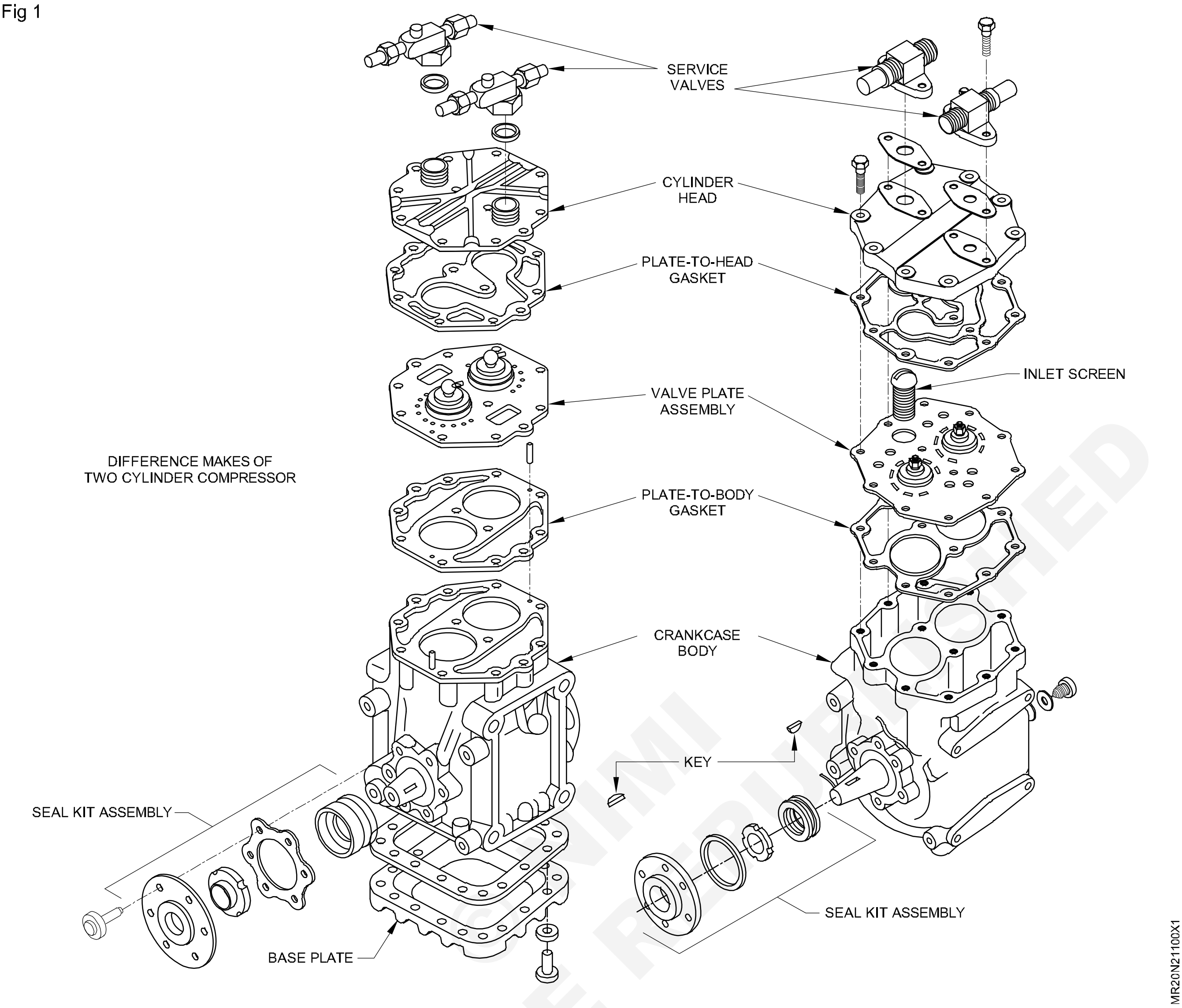
Compressor make:

Model No.:

Sl. No.	Name of the part	Physical Condition	Remarks
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Trainees **Instructor**

Fig 1


SERVICE VALVES
CYLINDER HEAD
PLATE-TO-HEAD GASKET
INLET SCREEN
VALVE PLATE ASSEMBLY
DIFFERENCE MAKES OF TWO CYLINDER COMPRESSOR
PLATE-TO-BODY GASKET
CRANKCASE BODY
KEY
SEAL KIT ASSEMBLY
SEAL KIT ASSEMBLY
BASE PLATE
MR20N21100X1

Check and service valve plate and piston assembly

Objectives: At the end of this exercise you shall be able to
• check and service valve assembly
• check and service piston assembly.

Requirements

Tools/Instruments

- Flat file - 1 No.
- Feeler gauge - 1 No.
- Nose plier - 1 No.
- Scrapper - 1 No.
- Brass rod - 1 No.
- Circlip plier - 1 No.
- Double end spanner (7 mm to 14 mm) - 1 Set.
- Screw driver 200 mm - 1 No.
- Combination plier - 1 No.
- Hammer (ball pein) - 1 No.
- Mallet - 1 No.

Equipment/Machines

- Valve plate assembly - 1 Set.
- Piston assembly with crank shaft - 1 Set.

Materials

- Tray (GI 12” x 12”) - 1 No.
- Refrigeration oil - ½ litre.
- Kerosene - 0.5 lt.
- Banian cloth - 1 Sq.m.
- Coir rope - 1 m.

PROCEDURE

TASK 1 : **Check and service valve assembly**

1 Keep the valve assembly on lapping plate.

2 Place the valve as the reed is upward.

3 Pour kerosene on the valve and check, if the kerosene drops out of the valve assembly, it has to be serviced.

4 Clean the valve assembly thoroughly with kerosene and wipe with banian cloth.

5 Check again for leakage.

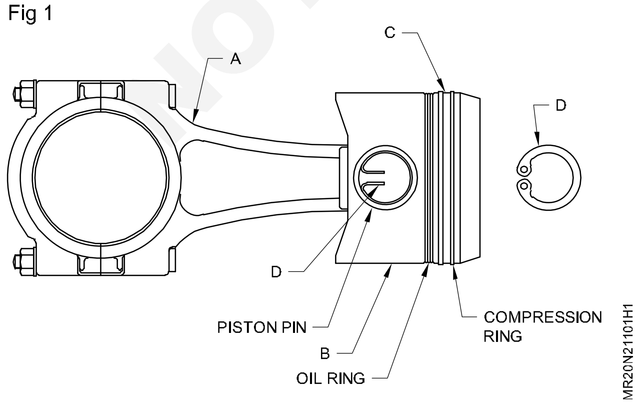
— — — — — — — —

TASK 2 : **Check and service piston assembly**

1 Refer Fig 1, identify each part of the connecting rod, and how it has connected with piston.

2 Identify the tools required, specify the size of each tool to dismantle the given connecting rod from crank shaft and piston assembly.

Fig 1



3 Remove the split pin from the end of connecting rod halves bolts and nut.

4 Remove the bottom halves of the connecting rod, split the halves section bearings.

5 Put your hand inside the crank case opening, push the connecting rod upwards and bring the connecting rod and piston out through the cylinder bore.

6 Place the circlip plier inside the circlip holes apply some pressure and release the circlip

7 Remove the gudgeon or piston pin, use the brass rod, and with the hammer give a gentle tap on the rod, which is placed on the end of the piston pin, soon as the pin jet out, use the plier and bring it out.

8 Keep all the spares in order in the tray.

Record the number of piston and cylinders and their description in Table 1 of Record sheet.

Table 1

	Cylinder	Piston
Nos.		
Dia.		
Remarks		

9 Check the hot spots of the bearing, and clean it with the use of bearing scraper.

10 Check the piston for scoring, then polish it.

11 Check the cylinder bore for any scratches and remove it by applying the lapping paste and rub it by the coir rope till it get smooth.

12 Check the piston ring grooves and the piston rings condition. (Fig 2)

13 Check the piston crown of any foreign materials and clean it.

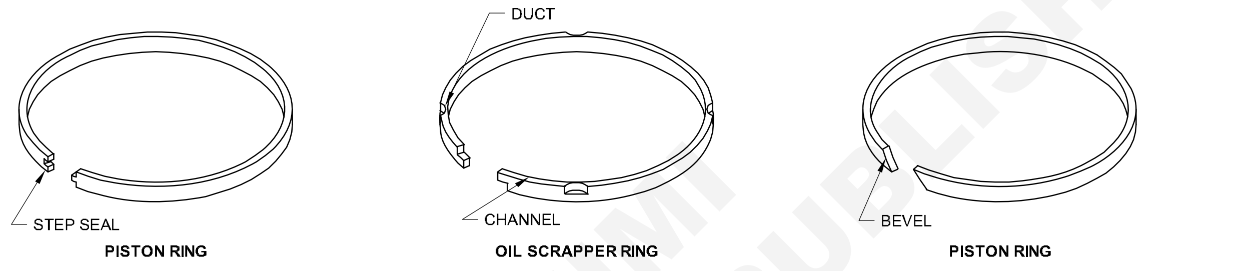
14 Check the scoring of gudgeon pin emery it with suitable gun metal bush.

Record the remarks of the piston and cylinder before and after service in the Table 2 of Record sheet.

Table 2

	Before Service remarks	After Service remarks
Cylinder No.1		
Cylinder No.2		
Piston No.1		
Piston No.2		
Instructor's remarks		

Fig 2



15 Check the slots in the oil scrapper rings.

16 Check the edges of the piston rings for damages.

17 Insert the rings into the bore and set equal distance. (Fig 3)

18 Check the butt clearance with the use of feeler gauge and record the readings in the Record sheet.

Record sheet

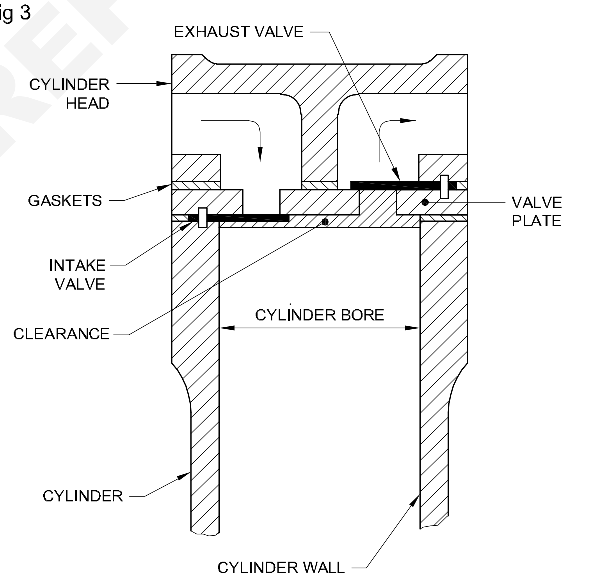
Table 3		
Cylinder No.	**Clearance before service**	**Clearance after service**
1		
2		
Remarks of the Instructor regarding the exercise		

Table 4	
Size of Cylinder	**Standard of butt clearance for rings**
1 inch	0.001"
2 inch	0.002"
3 inch	0.003"
4 inch	0.004"

19 For every 1 inch of bore the gap should be 0.001". If the gap is more replace the ring.

20 If the gap is less, with the use of the flat smooth file the gap side to be filed.

Fig 3



21 Check the clearance again it should be fixed in the cylinder.

22 When new rings are to be used the gap is to be checked and maintained.

For safety while filling the gap - make sure that it is not filed excess.

Make sure that the sharp edges are not damaged while filling.

Lapping valve plate, prepare gasket and refit

Objectives: At the end of this exercise you shall be able to
- **leak check the valve assembly**
- **lap the reeds and plate**
- **inspect and assemble the valve plate**
- **prepare gasket and refit.**

Requirements

Tools/Instruments

• Box spanner	- 1 Set.
• Hammer	- 1 No.
• Mallet	- 1 No.
• Double end spanner (7 mm to 14 mm)	- 1 Set.
• Screw driver 200 mm	- 1 No.
• Cutting plier	- 1 No.
• Gasket cutting scissors	- 1 No.
• Gasket cutting chisel or cutter knife	- 1 No.
• Hollow punch	- 1 No.
• Lapping plate	- 1 No.

Equipment/Machines

• Compressor valve plate assembly	- 1 No.

Materials

• Valve grinding paste (fine/coarse)	- 10 g.
• Refrigeration oil	- ½ litre.
• 12"/12" G.I Tray	- 1 No.
• Kerosene	- ½ litre.
• Banian cloth	- 1 Sq.m.
• Gasket	- as reqd.
• Oil can	- 250 ml.

PROCEDURE

TASK 1 : **Leak check the valve assembly**

1 Keep the valve assembly on lapping plate.

2 Place the valve as the reed upward.

3 Pour kerosene on the valve and check, if the kerosene drops out of the valve assembly, it has to be serviced.

TASK 2 : **Lap the reeds and plate**

1 Remove the reeds assembly from the valve plate.

2 Clean the plate apply lapping paste on the plate.

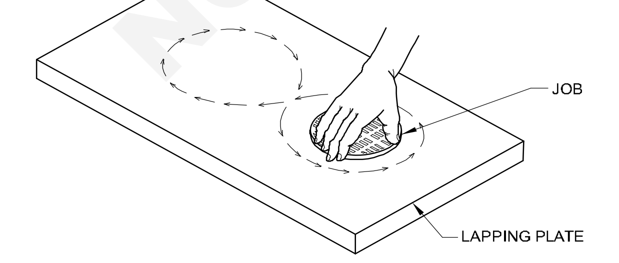
3 Place the valve plate in the lapping plate.

4 Move valve plate with finger in motion and form as No.8.

5 Apply even pressure after every forms of 8.

6 Turn the plate ¼" turn clockwise.

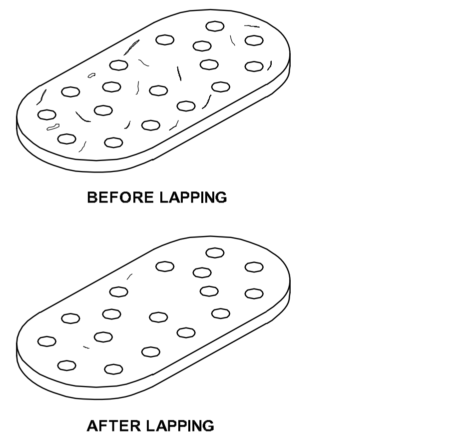
Fig 1



7 Repeat turning and lapping till the scratches on the plate is cleaned. (Ref. Fig 1 & 2)

8 The same to be repeated for lapping of the valve reeds.

Fig 2



TASK 3 : **Inspect and assemble the valve plate (Fig 1)**

1 Clean the valve plate and reeds with kerosene and wipe with banian cloth.

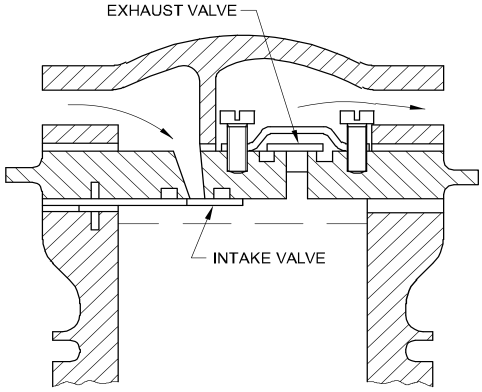
2 Rinse the parts in petrol. Inspect the parts so that no scratches are visible

3 Apply a film of refrigeration oil.

4 Assemble the reeds to the plate and tighten the screws.

5 Pour kerosene and check for leak.

Fig 1

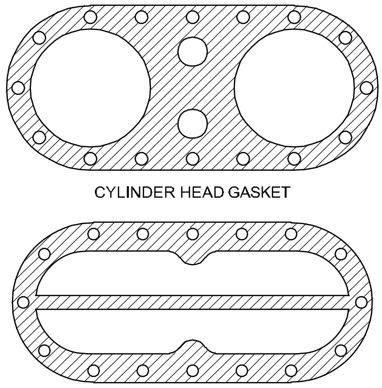


TYPICAL COMPRESSOR VALVE PLATE

TASK 4 : **Prepare gasket and refit (Fig 1)**

1 Check the gasket which removed with care, while dismantling, reject the damaged gasket or compressed too thin.

Fig 1



2 Select the re-usable gasket suitable to the location of the parts and choose the correct thickness of the gasket with instructor's guidance.

3 Cut a piece of gasket, little more than the size of the part from the gasket roll.

4 Place the gasket on the surface of the part, get the impression of two holes opposite to each other by rubbing with a small spanner on these holes.

5 Punch these holes by a gasket punch.

6 Again fix the gasket on the surface of the part with two bolts (opposite)

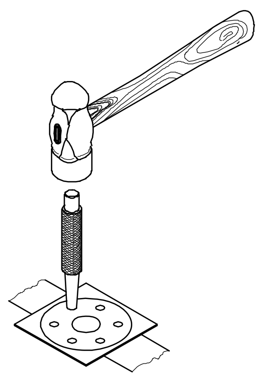
7 Hold the gasket properly, rub the edges of the part with a small spanner, and get the impression of the part on the gasket.

8 Remove the gasket and cut it on the impression of outer marks by gasket cutting scissors, inner marks by cutter blade, use the hammer and hollow punch to punch the holes.

9 While punching the holes, keep any waste or old gaskets down the new gasket to save the hole punches cutting edge.

10 Hold the hollow punch straight and hit the head with the hammer till the complete circumference of the hole cuts. (Fig 2)

Fig 2



CORRECT POSITION OF HOLLLOW PUNCH & HAMMER WHILE PUNCHING HOLE

11 Record the list of re-use gaskets, new gaskets, locations, and each one's thickness in the Record Sheet.

12 Apply thin film of oil on both surfaces of the gaskets.

13 Place gaskets at appropriate locations and refit.

Record sheet

Table 1

Location where used	Reused gasket thickness	Newcut gasket thickness

Table 2

Clearance checked between	Feeler gauge readings	Remarks

Check belt tension and replace

Objectives: At the end of this exercise you shall be able to
- **align the compressor to the drive system and check the belt tension**
- **replace belt**
- **run and check the machine.**

Requirements

Tools/Instruments

• Double end spanner set 8-22 mm	- 1 Set.
• Right spanner set 8-32 mm	- 1 No.
• Screw driver 150-300 mm	- 1 No.
• Spirit level 200 mm	- 1 No.
• Adjustable spanner 300 mm	- 1 No.

Equipment/Machines

• Reciprocating compressor with fly wheel	- 1 No.
• 'V' - belt with guard section	- 1 No.

Materials

- Bolts & Nuts with washer
- 'V' - belts

PROCEDURE

TASK 1 : **Align the compressor to the drive system and check the belt tension**

1 Loosen motor sliding adjustment screws and bolts base.

2 Positions the compressor & motor pulley in a line.

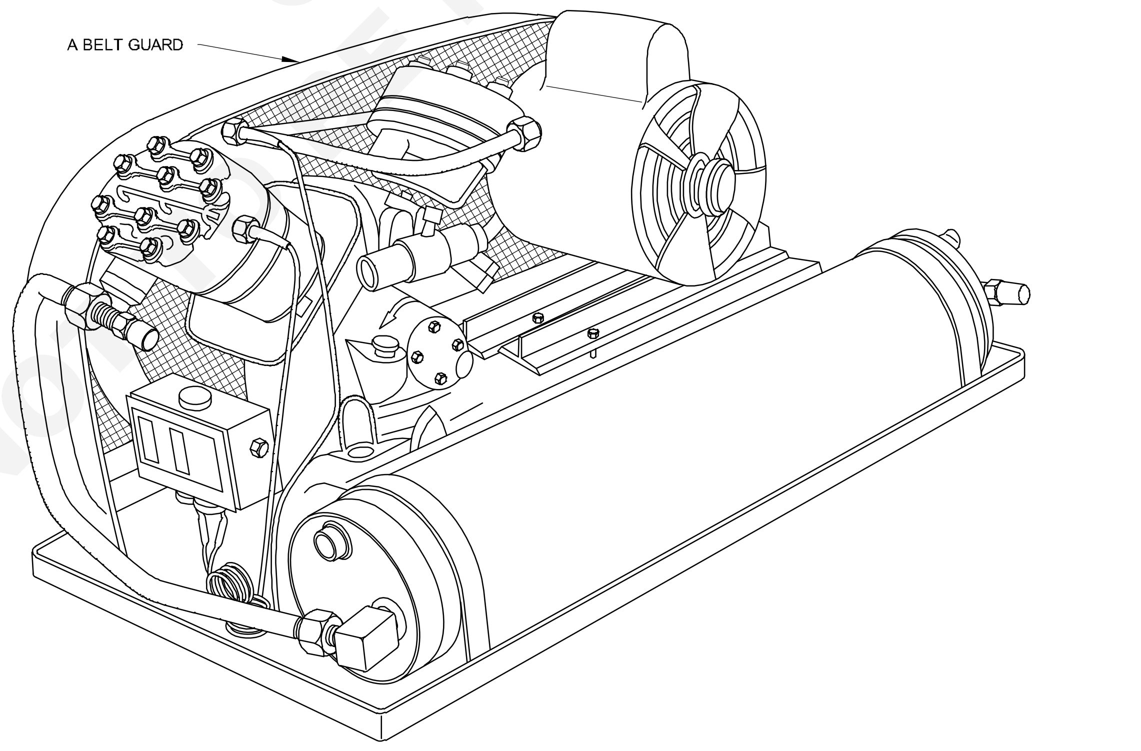
3 Measure the line with thread at center point of the both pulley.

4 Ensure that the both the pulley may be adjusted by adjusting base sliding adjustment long bolts.

5 Tighten the compressor base bolts.

6 Check the tension of the belts.

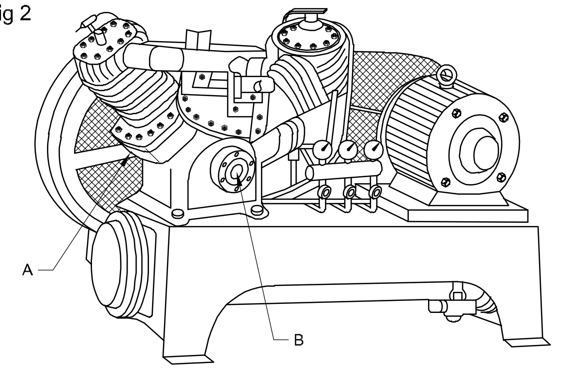
Fig 1



7 Tension the belts by adjusting the motor sliding base screws inside the channel as required.

8 Check the tension & balance the belt by spirit level. (Fig 1 & Fig 2)

Fig 2



CONDENSING UNIT WITH SHELL AND TUBE CONDENSER

TASK 2 : **Replace belt**

1 Loosen the compressor base bolts, after remove the ‘V’-belt guard.

2 Fit the V-belts on the motor and compressor pulley.

3 Place the straight edge face on the motor fully outer face with the respect to the motor fully and align the compressor.

4 Tighten the compressor base bolts full tight. Use suitable ring spanner.

5 Loosen the motor base bolts so that the nut is not loaded.

6 Ensure that the motor connection cable is flexible.

7 Repeat the steps 7 and 8 task 1.

TASK 3 : **Run and check the machine**

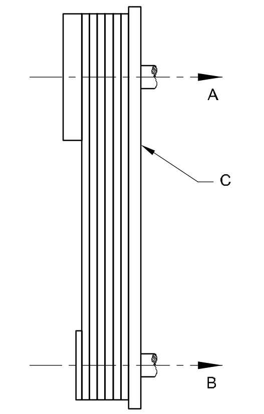
1 Run the machine & check the running performance.

2 Check the vibration.

3 Check the noise level

4 Check the current of motor. (Fig 1)

Fig 1



Check and test lubrication system

Objectives: At the end of this exercise you shall be able to
• check and test lubrication system.

Requirements

Tools/Instruments

- Double end spanner set 12 mm to 17 mm
- Ring spanner set 12 mm to 17 mm
- Screw driver 250 mm - 1 No.
- Pipe wrench 300 mm - 1 No.
- Wooden mallet - 1 No.

Equipment/Machines

- Open type compressor with lubrication oil pump

Materials

- Petrol - 500 ml.
- Banian cloth - 1 Sq.m.
- Lubrication oil - 1000 ml.
- Oil can - 1 No.
- Funnel - 1 No.
- Goggles - 1 Set.

PROCEDURE

TASK 1: **Identify the Lubrication oil circulation system, Lubrication oil pump and drive (Fig 1)**

1 Identify the parts which are used in lubrication system. (Refer Related Theory).

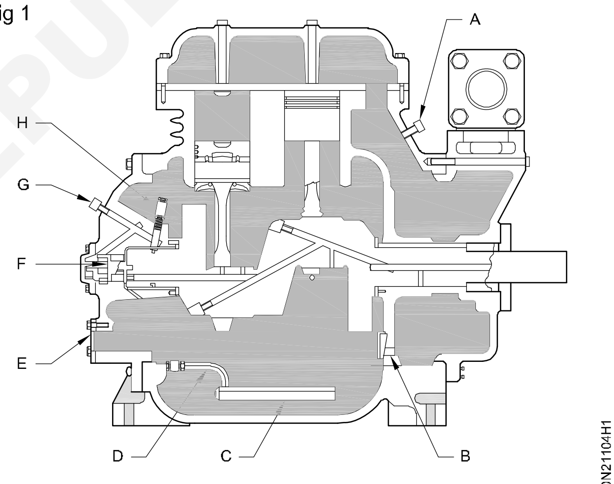
2 Check the gear connection between the crank shaft and the lubrication oil pump.

3 Check the gear of the lubrication oil pump's back-lash (Refer Related Theory)

4 Identify the oil pressure regulating valve

5 Identify the oil pressure gauge and oil pressure failure switch line.

Fig 1



DIRECT DRIVE RECIPROCATING COMPRESSOR'S CUT VIEW.

— — — — — — — —

Servicing of filter and oil pump

Objectives: At the end of this exercise you shall be able to
- **check and replace the strainer - clean the oil filter or strainer**
- **service oil pump.**

Requirements

Tools/Instruments

- Double end spanner set 12mm to 17mm - 1 Set.
- Ring spanner set 12mm to 17mm - 1 Set.
- Screw driver 250mm - 1 No.
- Pipe wrench 300mm - 1 No.
- Nitrogen cylinder valve key - 1 No.
- Wooden mallet - 1 No.
- Dot punch 100 mm - 1 No.
- Hammer (ball pein) 250 gm - 1 No.

Equipment/Machines

- Open type compressor with lubrication oil pump
- Dry nitrogen cylinder with the hose provided valve

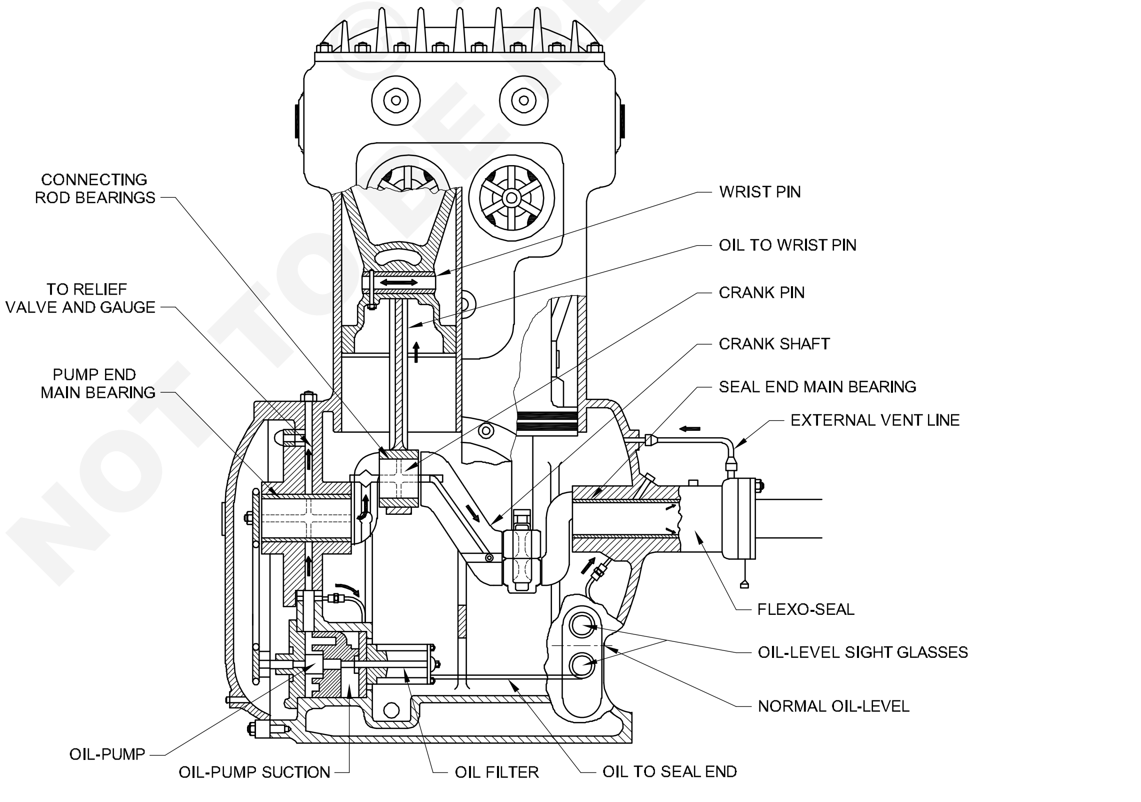
Materials

- Petrol - 500 ml
- Banion cloth - 1 Sq.m
- Lubrication oil - 1000 ml
- Oil can - 1 No.
- Funnel - 1 No.
- Goggles - 1 Set
- Kerosene - 500 ml

PROCEDURE

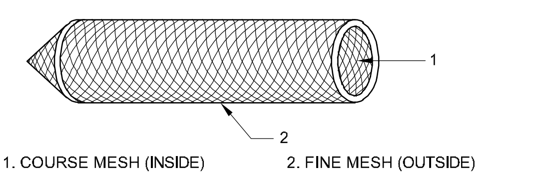
TASK 1: **Check and replace the oil strainer - Periodic check and service of oil filters (Fig 1 & 2)**

Fig 1



LOCATION OF THE OIL FILTER (STRAINER)

Fig 2



LUN OIL FILTER ELEMENT (STRAINER)

1 Pump down the system.

2 Remove the crank case cover. Remove the crank case oil filter element (If the filter is totally damaged replace the same size).

3 Rinse with petrol and clean, flush with dry nitrogen.

4 Check for foreign particles (bearing pieces) in the filters, remove it without damaging the filter element.

5 Rinse it in lubrication oil and fit it.

6 Care should be taken while flushing with nitrogen (with the instruction of the instructor).

7 Put the compressor in line check the lubrication oil pressure, note and compare the improvement of oil pressure after servicing the filter element. (Record it in the Record sheet.)

— — — — — — — —

TASK 2: **Servicing of oil pump (Fig 1)**

1 Remove oil pump from compressor body and place it on work bench in a tray.

2 Punch mark the matching parts to the body.

3 Remove external main drive gear.

4 Remove end cover bolts and open end cover.

5 Remove the dowel pins fixed in the body - tilt the pump and remove the drive gears.

6 Clean all the parts with kerosene .

7 Check for scoring or burrs, if any rectify.

8 Check the drive and drive gears for wear and tear, if and rectify.

9 Check the bearings, clean, lubricate or replace with new one with same specifications.

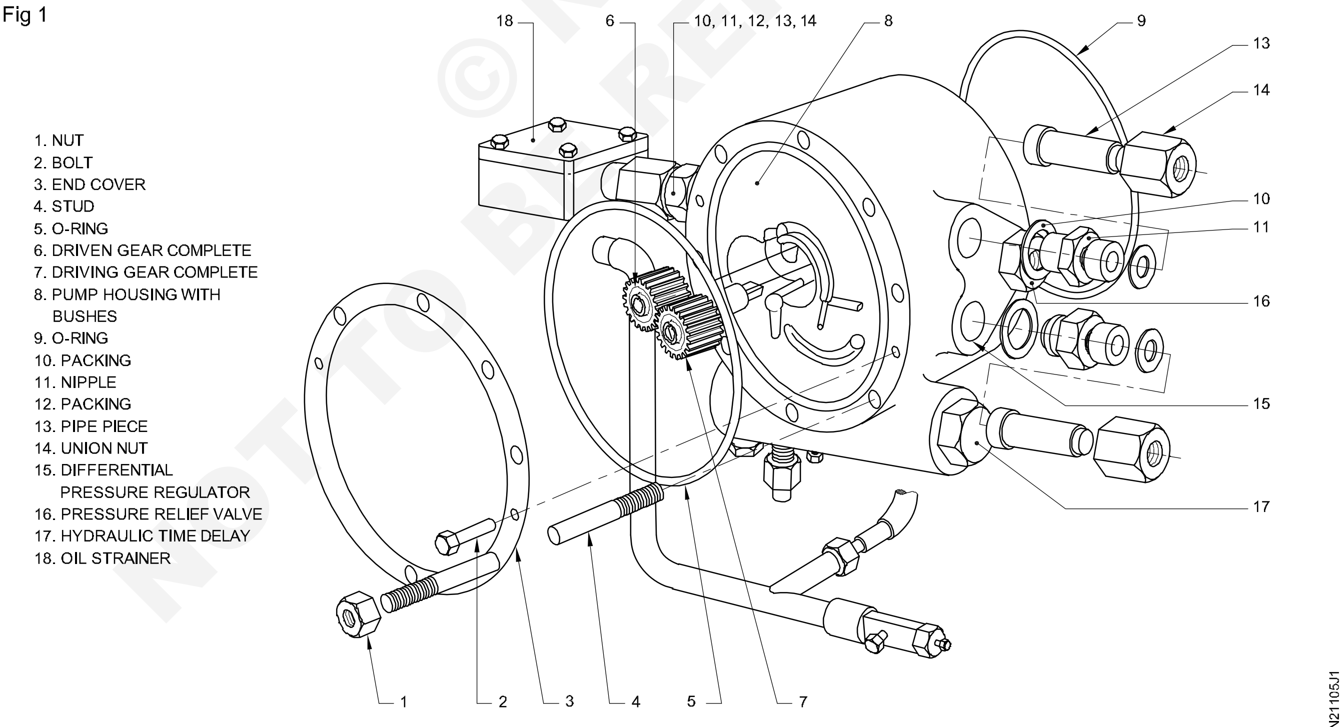
10 Assemble the oil pump and check the clearance between gear face and end cover.

11 Check the back lash between drive and driven gear.

12 Connect the oil pump to the compressor body by matching the pumps drive gear to the crankshaft gear.

13 Run the compressor and check the oil pressure.

Fig 1



SERVICING LUB OIL PUMP

Cutting gaskets

Objectives: At the end of this exercise you shall be able to
• check the use of all gaskets and cut new gaskets.

Requirements

Tools/Instruments

- Box spanner - 1 Set.
- Double end spanner - 1 Set.
- Hammer - 1 No.
- Mallet - 1 No.
- Gasket Cutting scissors - 1 No.
- Cutter knife or gasket cutting chisel - 1 No.
- Hole punch - 1 No.

Equipment/Machines

- Commercial compressor's spares
- Shaft seal assembly
- Arbor press

Materials

- Kerosene - 500 ml.
- Refrigeration oil - 250 ml.
- Oil can - 1 No.
- Gada cloth - as reqd.
- Gaskets - as reqd.

PROCEDURE

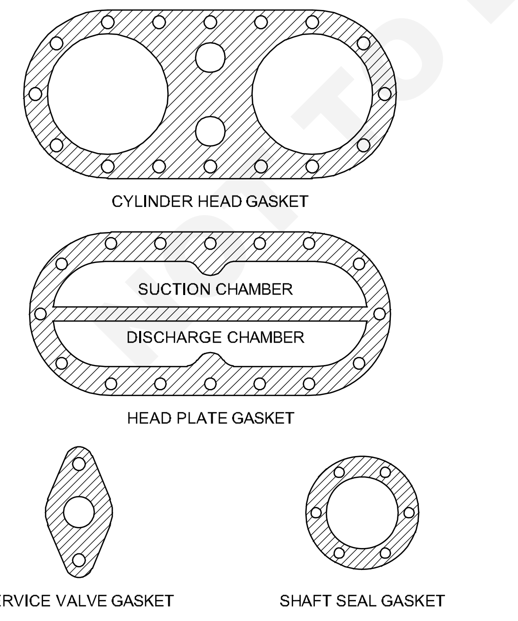
TASK 1 : **Check the use of all gaskets or cut new gaskets (Fig 1)**

1 Check the gaskets which removed with care, while dismantling, reject the damaged gaskets or compressed too thin.

2 Select the re-usable gaskets suitable to the location of the parts and choose the correct thickness of the gaskets with instructor's guidance.

3 Cut a piece of gasket, little more than the size of the part from the gasket roll.

Fig 1



SOME OF THE COMPRESSOR SPARES GASKETS

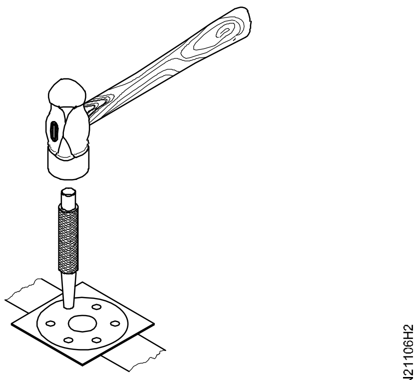
4 Place the gasket on the surface of the part, get the impression of two holes opposite to each other by rubbing with a small spanner on these holes.

5 Punch these holes by a gasket punch.

6 Again fix the gasket on the surface of the part with two bolts (opposite).

7 Hold the gasket properly, rub the edges of the part with a small spanner, and get the impression of the part on the gasket.

Fig 2



CORRECT POSITION OF HOLE PUNCH & HAMMER WHILE PUNCHING HOLE

8 Remove the gasket and cut it on the impression of outer marks by gasket cutting scissors, inner marks by cutter blade, use the hammer and hole punch to punch the holes.

9 While punching the holes, keep any waste or old gaskets down the new gasket to save the hole punches cutting edge.

10 Hold the hole punch straight and hit the head with the hammer till the complete circumference of the hole cuts. (Fig 2)

11 Record the list of re-use gaskets, new gaskets, locations, and each one's thickness in the Record Sheet.

Record sheet

TABLE 1

Sl. No.	Re-used gaskets to joints details	New gasket to joints details	Remarks

Trainee: Instructor:

Assemble compressor and test overall efficiency

Objectives: At the end of this exercise you shall be able to
- **check the components before assembly**
- **assemble compressor**
- **test overall efficiency.**

Requirements

Tools/Instruments

• Compound and pressure gauge	- 1 Set.
• Open end spanner set	- 1 Set.
• Socket set	- 1 No.
• Torque wrench	- 1 No.
• Circlip plier	- 1 No.
• Ring plier	- 1 No.
• Valve key	- 1 No.

Equipment/Machines

• Commercial reciprocating compressor	- 1 No.

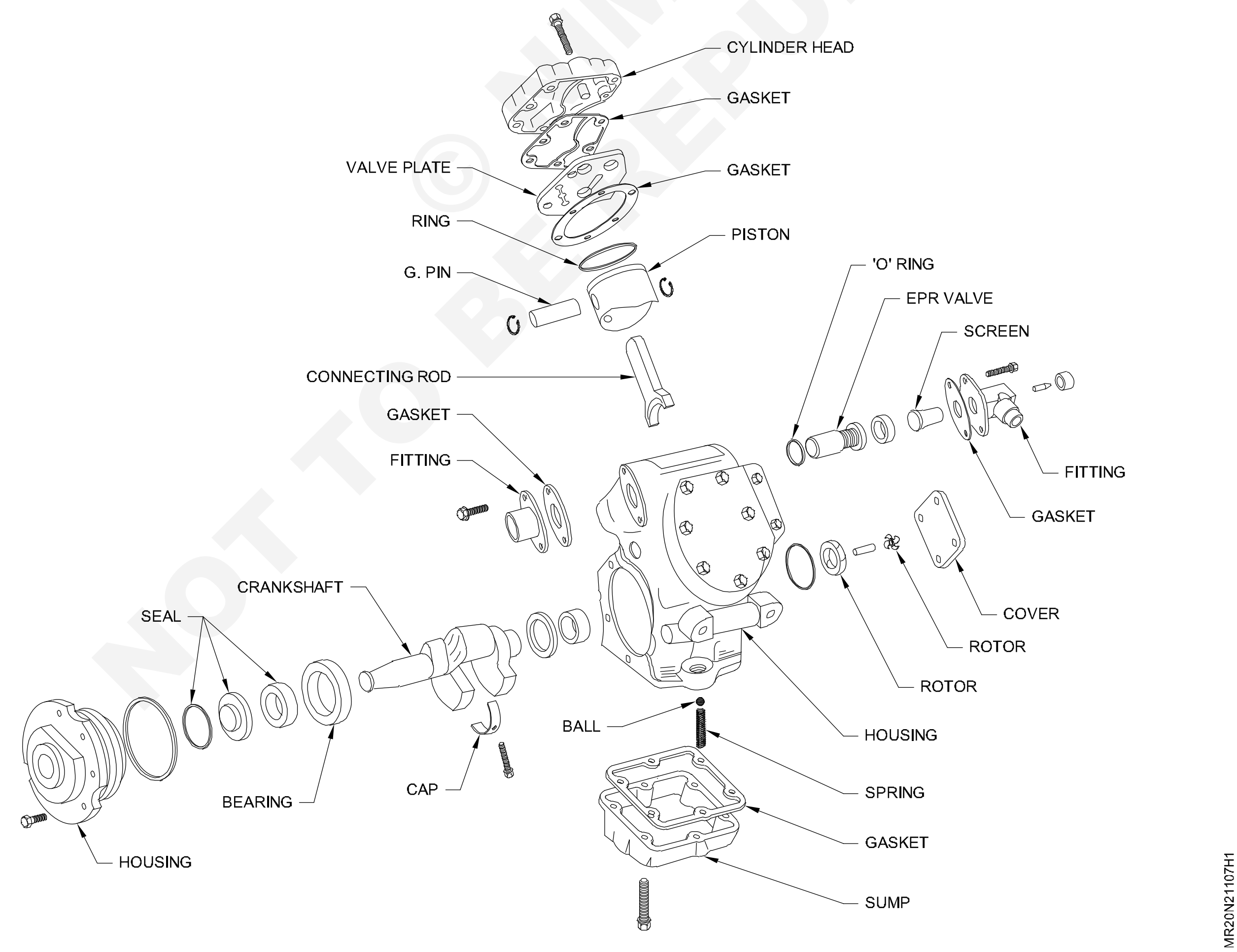
Materials

• Banian cloth	- as reqd.
• Refrigerant oil	- as reqd.
• Gasket kit	- 1 set.
• Crankshaft side seal	- 1 set.

PROCEDURE

TASK 1 : **Check the components before assembly (Refer Fig 1)**

Fig 1



1 Cylinder bore should be free from wear, scoring and seizure marks. Recondition/Replace if found with defect. Refer workshop manual.

2 Connecting rod should be free from bend and twist. Recondition if found with defect.

3 Piston grove side clearance should be within specification. If excess replace the piston assembly. Refer workshop manual.

4 Piston ring end gap should be within specification. (Refer Fig 2)

Fig 2

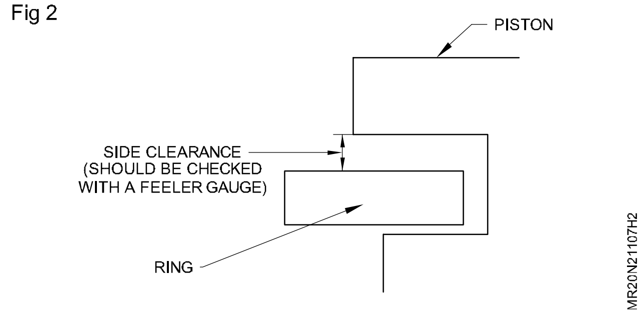
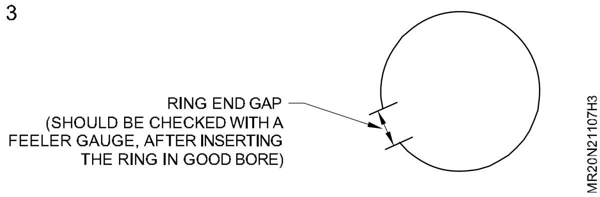


Fig 3



5 Cylinder head should be free from distortion. If so found, then replace.

6 Crankshaft journals should be free from wear, scoring and seizure marks. If found replace.

7 Crankshaft should be free from bend. If found remove bend.

8 Crankshaft bearings should be free from wear. If so found, replace the bearings.

9 Check the oil pump rotor wear check clearance. If found with excessive clearance replace the pump assembly. Refer workshop manual.

When assembling a compressor (2 cylinder V type use new gasket kit and side seal)

Record sheet

Date:

Compressor make:

Model No.:

Sl. No.	Name of the part	Physical Condition	Physical Dimensions (mm)	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

— — — — — — — —

TASK 2 :**Assemble compressor**

1 Fit the crankshaft to the housing.

Position bearings, seal and housing and use specified torque (refer workshop manual).

2 Fit the connecting rod to the compressor piston with the help of G.pin.

3 Position the circlips in the circlip grooves of the piston.

Use circlip plier.

4 Fit the piston ring in the piston groove.

Use ring plier.

5 Insert the piston assembly into the cylinder bores.

Use ring plier

6 Tighten the connecting rod cap bolts with specified torque (refer workshop manual)

7 Keep the cylinder head gasket, valve plate and cylinder head in position and tighten the bolts with specified torque (refer workshop manual)

8 Fit the EPV valve in its position and tighten the bolts

9 Fit the sump with specified torque. (refer workshop manual)

— — — — — — — — —

TASK 3: **Test overall efficiency of the compressor**

1 Stop the compressor, if it is running, in presence of instructor and bypass the low pressure cut out switches electrical contacts.

2 After the vapour pressure equalize, check and ensure the gauge lines are leak proof.

3 Close the valves for gauge lines and ensure both, compound pressure gauges read zero. Now open the gauge valve and record the idle pressure of gas.

4 Check the crank case oil level is upto the mark.

5 Now close the suction valve and operate the compressor, Ref. Fig 1 for few minutes.

6 When the suction pressure drops to vacuum 600 mm Hg of the compound gauge, record the related discharge pressure reads by pressure gauge also, then stop the compressor.

7 Check the crankcase, seal any leakage of oil.

(If the suction gauge vacuum breaks (within 10 minutes) or discharge gauge pressure drops, it is the indication of leakage of valve seatings, cause the inefficiency of the compressor).

8 Observe the suction vacuum remains and discharge pressure also constant, it indicates the efficiency of the compressor (Refer Related Theory of Exercise No.3.1.174- 175).

9 Open the suction valve, remove the bypass of electrical contact to the low pressure cutout switch.

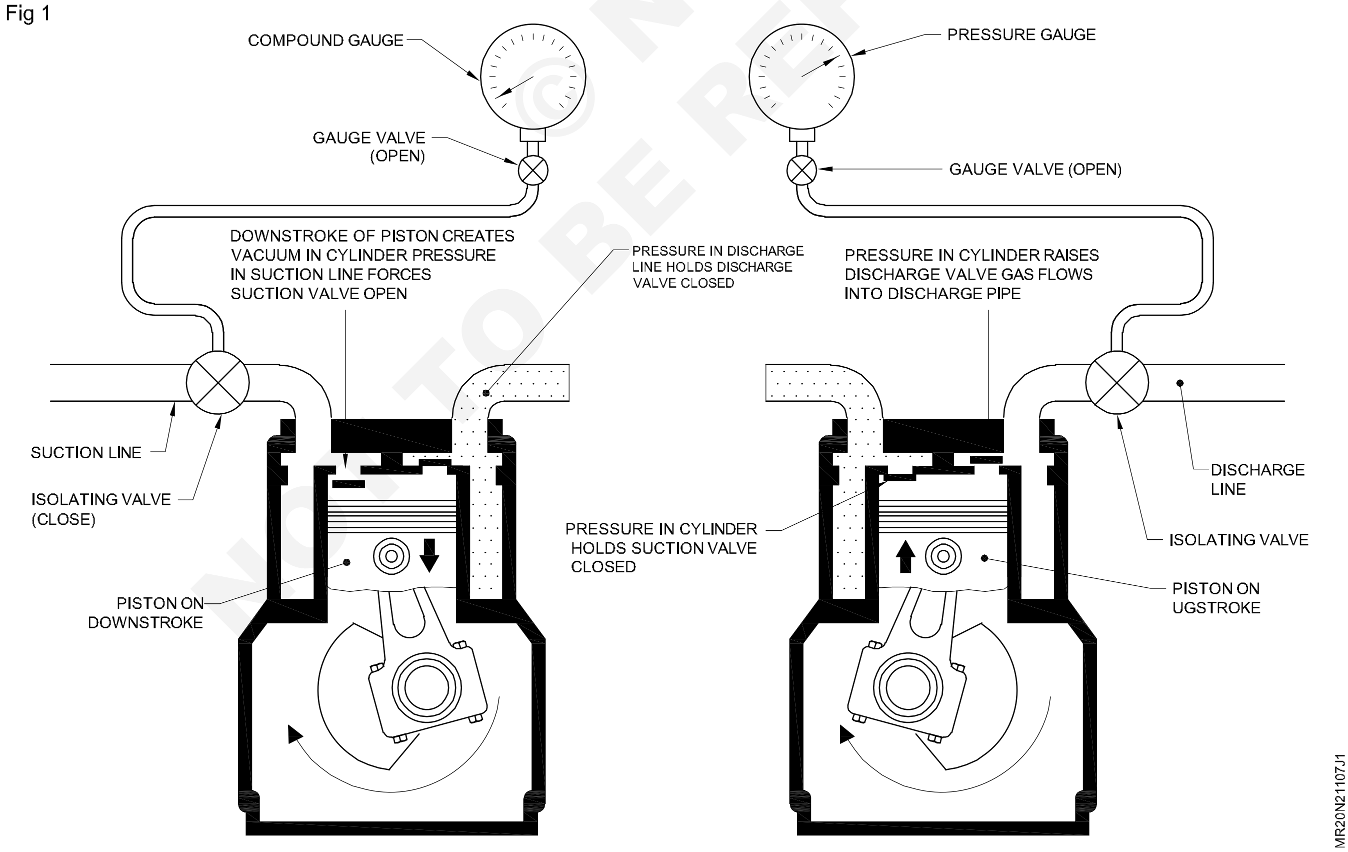
10 Start the compressor and operate the system.

11 Record the suction pressure and discharge pressure in respective gauges in Table-2 of Record Sheet.

12 Find the operational compression ratio i.e., the discharge pressure divided by suction pressure.

13 Fill up the tables which are given in the record sheet

Fig 1



Record Sheet

Table 1

Commercial Refrigeration system	Details
Compressor	Type : Capacity :
Condenser	
Evaporator	

Table 2

Refrigerant used	Idle pressure	Suction valve position	Suction pressure	Discharge pressure	Compression ratio
		Close			
		Open			

Operational Compression ratio = $\frac{\text{Discharge pressure}}{\text{Suction pressure}}$

Instructor's remark:

— — — — — — — —

Connect star and delta connection on a three phase motor

Objectives : At the end of this exercise you shall be able to
- **draw the star delta connection of motor winding through starter handle operation**
- **connect the manual star delta starter with 3 phase motor**
- **adjust the overload relay according to the motor current rating**
- **stop the 3 phase motor through the manual star delta starter**
- **measure line current and line voltage, phase current and phase voltage.**

Requirements

Tools/Instruments

- Insulated cutting plier 200mm - 1 No.
- Screw driver 20mm,300mm - 1 No each.
- Side cutter 150 mm - 1 No.
- Wire stripper - 1 No.
- M.I ammeter 10 amp - 1 No.
- M.I voltmeter -0- 500V - 1 No.

Equipment/Machines

- 3 phase squirrel cage induction motor 415 V 5HP - 1 No.
- Manual star -delta starter 16A,415V without overload relay and no volt coil - 1 No.

Materials

- Pre insulated standard aluminium cable 2.5 sq.mm 650V grade - 25 meter.
- Fuse wire 10 amps - as reqd.
- Black insulation tape - as reqd.
- ICTP switch 16A 415 V - 1 No.

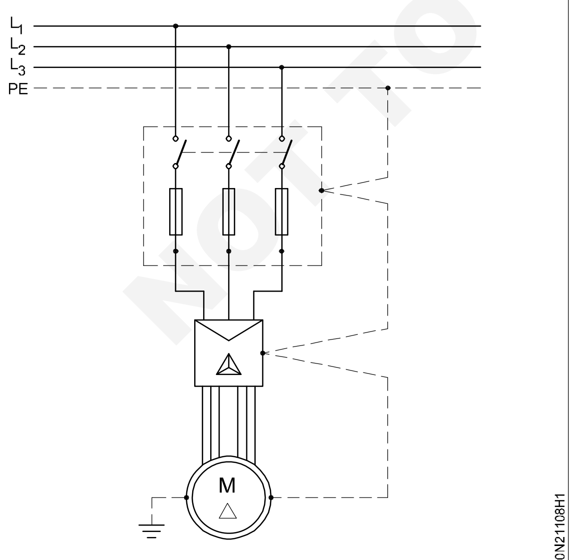
PROCEDURE

TASK 1: **Connect star and delta connection on a three phase motor**

1 Identify the parts of the star delta starter trace the connection and study its operation Draw the traced out circuit and get it approved by the instructor.

The layout diagram in the Fig -1. The schematic diagram of the star delta starter in Fig -2 and two types of practical circuits in Fig 3 and 4 are all given for your guidance only.

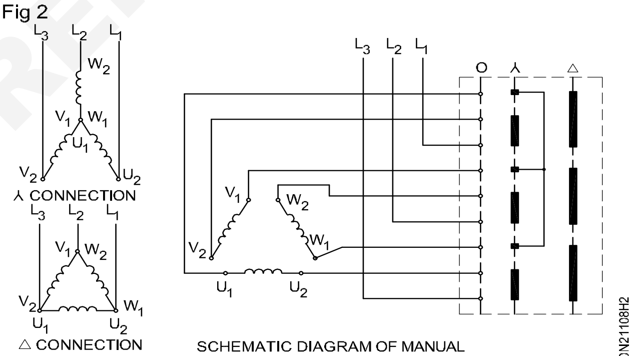
Fig 1



LAYOUT DIAGRAM OF STAR - DELTA STARTER CONNECTED TO THE MOTOR

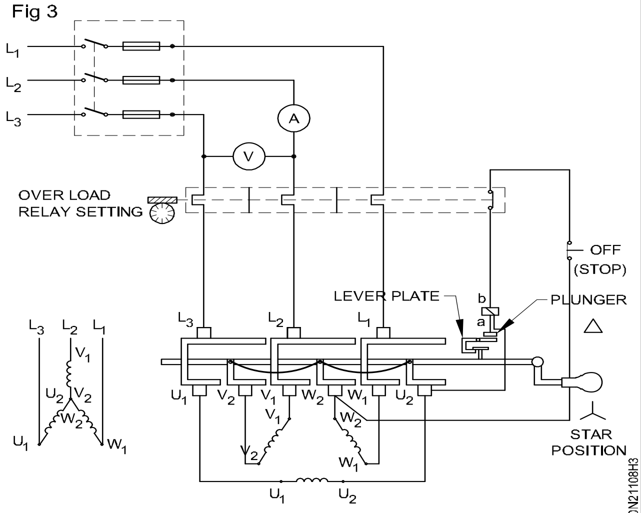
2 Draw the complete connection diagram with the ICTP switch., the given star delta starter and motor and get it approved by your instructor.

Fig 2



SCHEMATIC DIAGRAM OF MANUAL STAR-DELTA STARTER CONNECTIONS

Fig 3



STAR - DELTA SWITCH IN STAR POSITION

3 Make the connection of the motor starter and the ICTP switch as per the approved diagram.

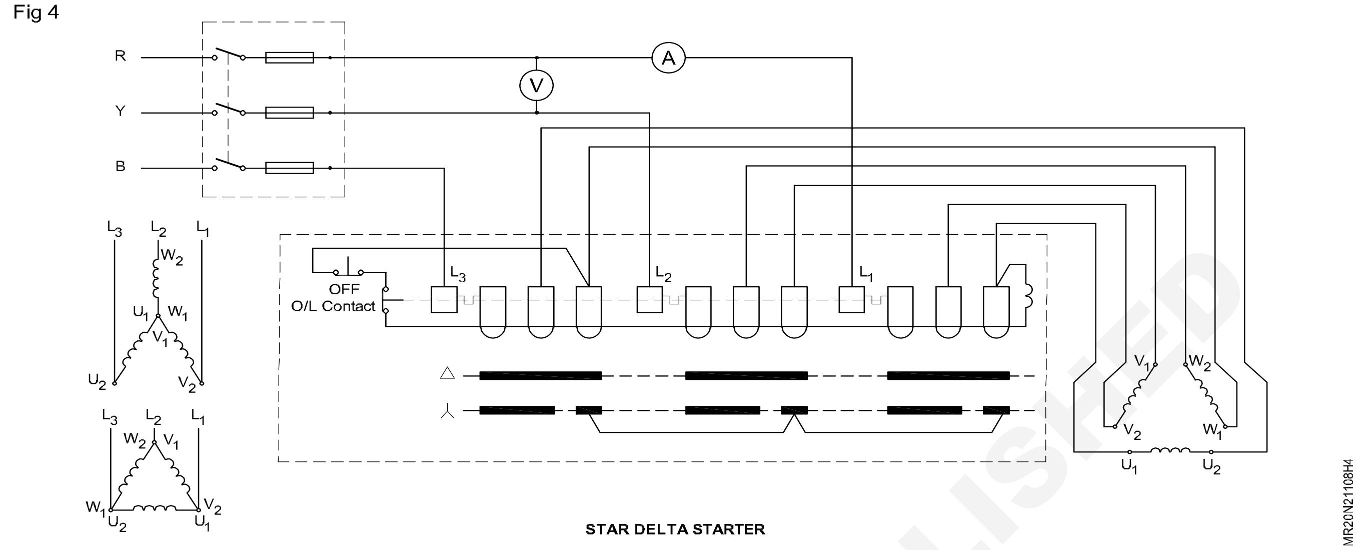
4 Connect three cables from supply L1,L2,&L3 to the main switch an shown in Fig 3 & 4.

5 Connect ammeter in series and voltmeter in parallel as shown in Fig 3 & 4.

6 Set the over load relay according to the full load current rating of the motor.

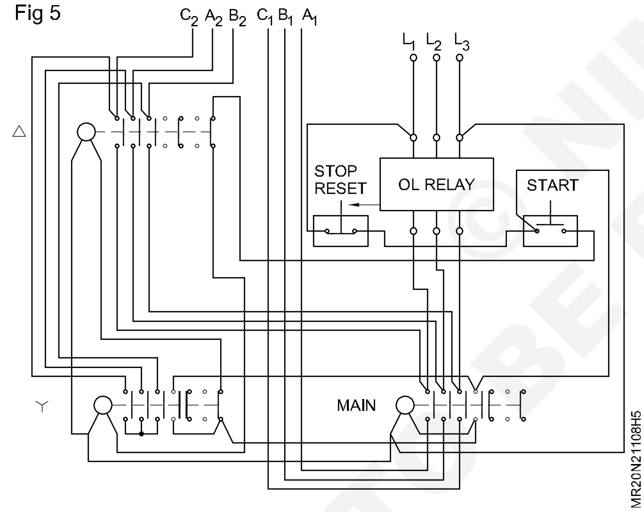
7 Switch 'ON' the main observe the voltmeter reading and move the handle to the star position positively and at the same time observe the starting current& voltage and enter it in Table 1.

Fig 4



STAR DELTA STARTER

Fig 5



8 Allow the motor to start race initially and let this sound of the rotating shaft come to a steady state. Then move the handle to the delta position positively

9 Note down the current & voltage taken by the motor in running condition and enter the value of the current Table1

10 Then stop the motor by pressing the stop button of the starter.

11 Power and control wiring of 3 phase motor refer Fig no 5 & 6

Fig 6

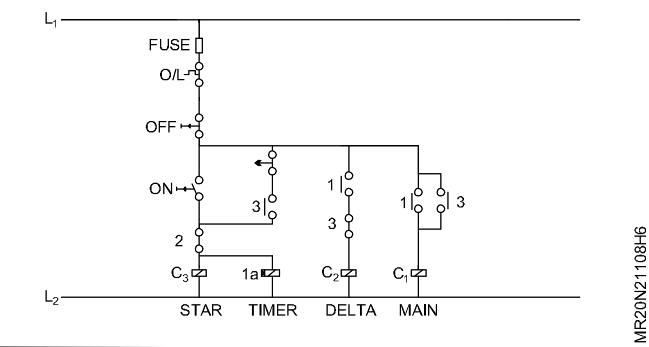


Table 1

Sl.No	Description	V_L in volts	I_L in amp	Vph in volts	Iph in amps
1	**Start starting current**				
2	**Delta Running current**				

Result :-

In Star :- The current and phase current are.....where as line voltage =.........x phase voltage

In Delta :-The line voltage & phase voltage are.......where as line current = ...x phase current

TASK 2: **Verify the relationship between Line and Phase values in star connection of three phase system**

1 Form the circuit as per the given circuit diagram. (Fig 1) with one lamp each connected to all the 3 phases (40/100/200 W).

2 Identify the 3-phase (L_1, L_2, L_3) and neutral (N) of supply terminals.

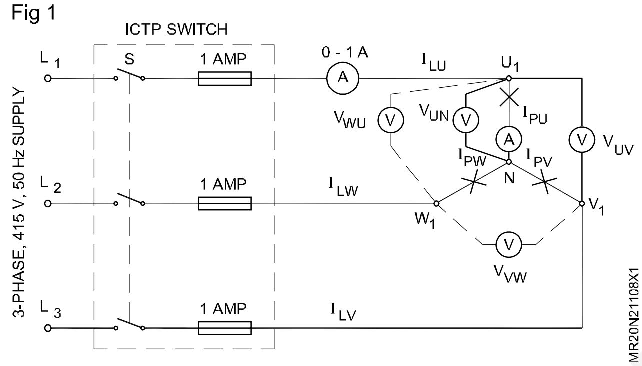
3 Switch 'ON' the 3-phase supply.

4 Measure the line voltage V_{UV} by placing the voltmeter leads between the two lines and enter the reading in Table 1.

5 Repeat for the other line voltages V_{VW}, V_{WU}.

6 Measure the phase voltages by placing the voltmeter leads between one line and star point N, and enter the readings in Table 1.

Fig 1



7 Measure the Line and Phase current and enter the readings in Table 1.

Switch 'OFF' supply before effecting any change in load.

8 Repeat steps 3 to 7 for different loads.

9 Calculate the ratio between the Line voltage and Phase voltage.

$$\frac{V_{UV}}{V_{UN}} =$$

$$\frac{V_{VW}}{V_{VN}} =$$

$$\frac{V_{WU}}{V_{WN}} =$$

10 Verify the ratio between Line current and Phase current, i.e.

$$\frac{I_{LU}}{I_{PU}} = \frac{I_{LV}}{I_{PV}} = \frac{I_{LW}}{I_{PW}} =$$

11 Get it checked by the instructor.

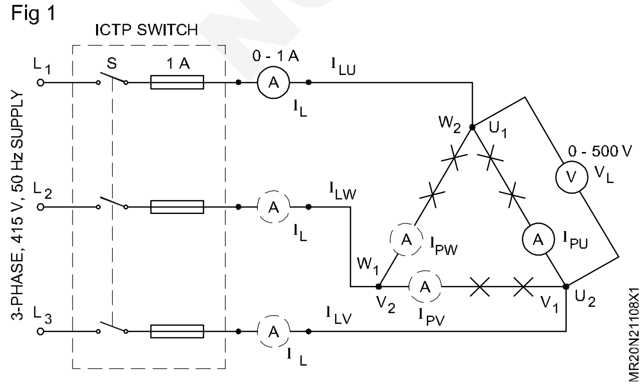
Table 1

Sl. No.	Load in watts per phase	Line voltage			Phase voltage			Line current			Phase current		
		V_{UV}	V_{VW}	V_{WU}	V_{UN}	V_{VN}	V_{WN}	I_U	I_V	I_W	I_{UN}	I_{VN}	I_{WN}
1	40W												
2	100W												
3	200W												

TASK 3: **Verify the relationship between Line and Phase values in delta connection in three phase system**

1 Form the circuit as per the given circuit diagram. (Fig 1) Two lamp in series to be connected between two phases of same voltage.

Fig 1



2 Switch ON the 3-phase supply. Measure the line voltages by connecting the voltmeter leads between two of the terminals U_1, V_1, W_1.

3 Measure the phase voltage by placing the voltmeter leads across the lamps, i.e. U_1, U_2 or V_1, V_2 or W_1, W_2.

4 Record the Line voltages and Phase voltages measured, under the appropriate column in Table 2.

5 Measure the Line and Phase currents and enter the readings in Table 2.

An ammeter connected between supply and load indicates Line current. An ammeter connected in series with single load (two lamps in series) indicates Phase current.

6 Repeat steps 2 to 5 for different loads.

Switch off the supply before effecting any change in the load.

7 Verify the relationship between Line and Phase value of current and voltage. Enter in Table 3.

Result

In star : Line current and Phase current are

whereas Line voltage = x Phase voltage.

In delta :Line voltage and Phase voltages are

whereas Line current = x Phase current.

8 Get it checked by the instructor..

Table 2

Sl. No.	Load in watts per phase	Line voltage			Phase voltage			Line current			Phase current		
		V_{U1V1}	V_{V1W1}	V_{W1U1}	V_{U1U2}	V_{V1V2}	V_{W1W2}	I_U	I_V	I_W	I_{U1U2}	I_{V1V2}	I_{W1W2}
1	40W												
2	100W												
3	200W												

Table 3

Load	$\frac{V_{U1V1}}{V_{U1U2}}$	$\frac{V_{V1W1}}{V_{V1V2}}$	$\frac{V_{W1U1}}{V_{W1W2}}$	$\frac{I_{LU}}{I_{PU}}$	$\frac{I_{LV}}{I_{PV}}$	$\frac{I_{LW}}{I_{PW}}$
40W						
100W						
200W						

— — — — — — — — —

TASK 4: **Measure the insulation resistance value between the windings**

1 Connect the test leads of the megger to the terminals U_1 and V_1. (Fig 1)

2 Rotate the Megger at its rated speed and note down the readings in Table 3.

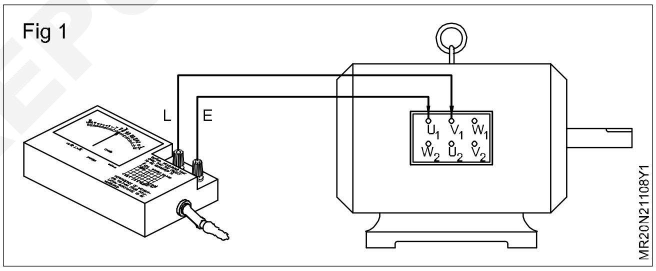


Fig 1

Table 3

Insulation resistance of 3-phase induction motor

Sl. No	Between terminals	Insulation resistance	Remarks
1	U_1 and V_1		
2	U_1 and W_1		
3	V_1 and W_1		
4	U_1 and frame		
5	V_1 and frame		
6	W_1 and frame		

3 Repeat the steps 1 and 2 by connecting the Megger terminals between U_1 and W_1, and also between V_1 and W_1. Record the findings in Table 3.

Recommended standard insulation resistance

$$R_1 = \frac{20 \times E\eta}{1000 + 2P} \text{ in megohm .}$$

where

R_1 = insulation resistance in megahms at 25^{0}C.

E_n = rated phase-to-phase voltage

P = Rated power in kW.

If the resistance is measured at a temperature different from 25°C, the value shall be corrected to 25°C.

The equation given here is used to calculate the insulation resistance as a standard value. However the accepted insulation value should not be less than 1 megaohms.

Identify the terminals of a squirrel cage induction motor

Objectives: At the end of this exercise you shall be able to
- **read and interpret the name-plate details of an A/C 3-phase induction motor**
- **test the 3-phase induction motor for continuity test**
- **identify the terminals of a 3-phase induction motor by (1) the two lamp method (2) the voltmeter method and (3) the single lamp method.**

Requirements

Tools and Instruments

- Insulated cutting plier 200mm - 1 No.
- Screwdriver 200mm with 4mm blade - 1 No.
- D.E spanner set, 5mm to 20mm - 1 set
- M.I voltmeter 0-300V - 1 No.
- M.I voltmeter 0-500V - 1 No.
- Test lamp 240V, 60 watts or 100 watts - 2 Nos.

Equipment/Machines

- AC 3-phase 415V, squirrel cage induction motor (any available capacity) - 1 No.

Materials

- PVC insulated stranded copper cable 1.5 sq.mm - 4 m
- Test lamp 240V AC with 40 watts bulb - 1 No.
- Pendent lamp-holder 240V 6A - 2 Nos.

PROCEDURE

1 Note down the name - plate details and enter in Table 1.

Table 1

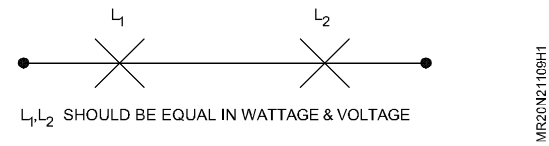
Name-plate details

Manufacturer, Trade Mark............................	Rated frequency....................................
Type, model or list number...........................	Rated power...............................k.w/HP
Type of current..	Rating class..
Function...	Insulation class.....................................
Fabrication or serial number.........................	Rated current............................. amps
Type of connection.....sep/shunt/series/compound	Rated speed................................r.p.m
Rated voltage... volts	Protection class.....................................

TASK 1: **Identifying the terminals of a 3-phase induction motor with the help of two lamps in series**

Lamps should be equally rated both in voltage and wattage. (Fig 1)

Fig 1

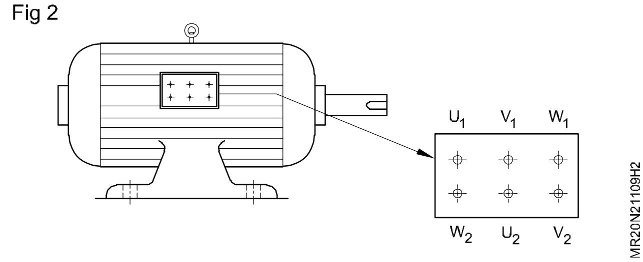


1 Test for continuity with the help of a test lamp and find the 3 pairs out of six terminals of the induction motor. (Fig 2)

2 Name the 3 pairs of terminals, name them as 'U' coil, 'V' coil and 'W' coil.

3 Tag U_1 and U_2 for 'U' coil only. For other coils tag V_1 and V_2 for 'V' coil and W_1 and W_2 for 'W' coil as shown in Fig 2

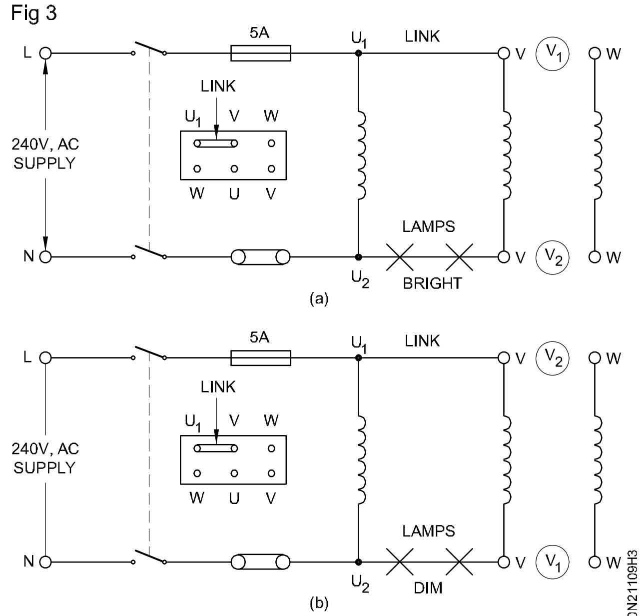
Fig 2



Assuming the terminal marked as U_1 by you is the beginning of coil U, proceed as below.

4 Connect the terminals U_1 to V and then connect the series combination of the lamps to the winding ends U_2 and V as shown in Fig 3a and give 250 AC voltage across U_1 and U_2.

Fig 3



IDENTIFICATION OF THE TERMINALS OF AN INDUCTION MOTOR (3-PHASE)

If the lamps glow bright as shown in Fig 3a then the linked ends are similar ends. For example, the linked ends are U_1 and V_1.

If the lamps glows dim as shown in Fig 3b, then the linked ends are dissimilar ends. For example, the linked ends are U_1 and V_2.

5 Mark the name of V coil terminals as V_1 and V_2. according to the test result.

When the current flows through the coils they produce magnetic fields. If similar ends are connected, the magnetic fields help each other and produce high voltage across the lamp terminals making them to glow bright. In the case of dissimilar connections, the voltage at lamp terminals will be low and the lamps will give dim light.

6 Test in the same way for the remaining terminals of coil 'W' and mark them as W_1W_2.

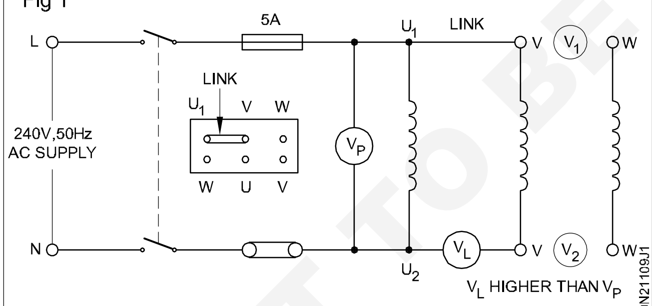
— — — — — — — — —

TASK 2: **Identifying the terminals of a 3-phase induction motor with the help of a voltmeter**

1 Repeat the steps 1 to 4 of TASK 1.

2 Connect the terminals U_1 and V with a link, connect a voltmeter V_L of 500V range between U_2 and V and a voltmeter V_P of 300V range between U_1 and U_2 as shown in Fig 1.

Fig 1



IDENTIFYING THE TERMINALS OF A 3-PHASE INDUCTION MOTOR

3 Switch 'on' the supply, if the voltmeter V_L reads more than V_P, then the linked terminals are similar as shown in Fig 4 (i.e U_1V_1).

4 Check the voltmeter V_L reads less than V_P, then the linked terminals are dissimilar (i.e U_1V_2). Mark them as U_1V_2.

5 Test in the same way the remaining terminals of coil 'W' and mark them as W_1 and W_2.

Normally small capacity, 3-phase induction motor terminals are arranged in the terminal box as shown in Fig 2 to facilitate either star or delta connection to be made in the terminal box itself by links and to be started by a D.O.L starter. Compare your terminal marking with the terminal marking given on the terminal plate. Discuss with your instructor and seek further clarification if there is any difference.

— — — — — — — — —

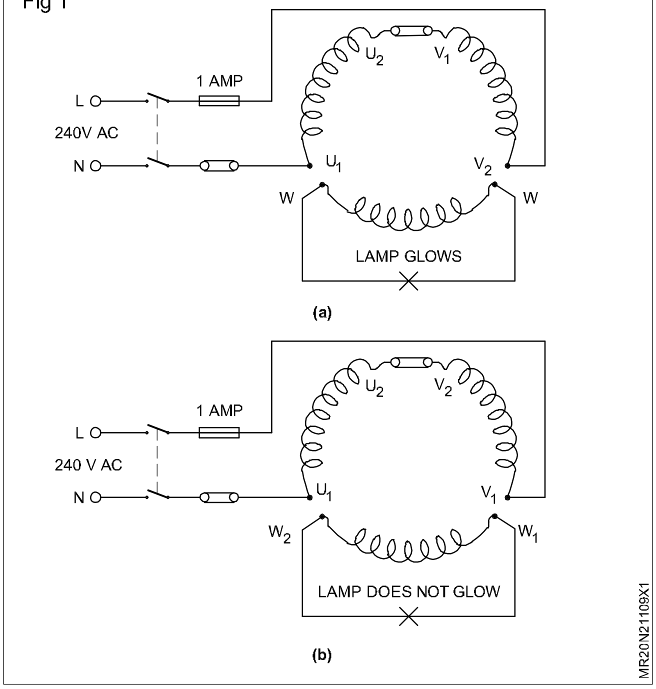
TASK 3: **Identifying the terminals of a 3-phase induction motor with the help of single lamp method**

1 Connect the terminals as shown in Fig 1a. Connect it to a 240V AC supply and switch on the supply.

2 Check the lamp glowing, the linked terminals are dissimilar. i.e U_2V_1. The bulb will glow. Mark them as U_2V_1.

If the lamp does not glow, the linked terminals are similar (i.e U_2V_2). (Fig 5b) Mark them as U_2 and V_2.

Fig 1



When current flows through the coils they produce magnetic fields. If dissimilar ends are shorted (linked) they assist each other and voltage induces in the third coil and the lamp glows. If similar ends are linked, the magnetic fields oppose each other and no voltage will be induced in the third coil. Hence the lamp does not glow.

— — — — — — — —

Start the motor through D.O.L. starter and measure starting current and show changing of DOR

Objectives: At the end of this exercise you shall be able to
- **start and stop the 3-phase induction motor through D.O.L starter**
- **measure the starting and the running currents of the 3-phase squirrel cage motor**
- **change the DOR.**

Requirements

Tools and Instruments

- Combination pliers 200mm - 1 No.
- Screwdriver 300mm with 4mm blade - 1 No.
- Connector screwdriver 100mm - 1 No.
- Side cutting pliers 200mm - 1 No.
- Electricians knife 100mm - 1 No.
- Ammeter MI 0-20 amp - 1 No.
- Voltmeter MI 0-500V - 1 No.
- Plumb bob with thread - 1 No.
- Spirit level - 1 No.
- Tachometer 0-3000 rpm - 1 No.

Equipment/Machines

- 3-phase squirrel cage motor 3 HP 415V, 50Hz - 1 No.
- D.O.L starter 10 amp 415V with overload relay, no-volt coil & push-button station - 1 No.
  (The instructor is requested to dismantle the contactor, overload relay and the internal connecting hook-up cables before giving the equipment to the trainees)

Materials

- PVC insulated, single strand copper cable 16 SWG - 0.5m.
- PVC insulated, single strand copper cable 18 SWG - 0.5m.
- Machine screws 2 BA, 30mm long with 2 washers and one nut - 4 Nos.
- I.C.T.P switch 16A 415V - 1 No.

PROCEDURE

1 Note down the name-plate details of the given AC 3-phase squirrel cage induction motor in Table 1.

2 Collect the contactor unit, overload relay unit, start/stop push-button unit, the necessary fixing screws, hook up cables, I.C.T.P switch and D.O.L starter base and cover.

Table 1

Name - plate details

Manufacturer, Trade Mark.............................	Rated frequency.......................
Type, model or list number............................	Rated power...................k.w/HP
Type of current..	Rating class............................
Function...........................	Insulation class.........................
Fabrication or serial number..........................	Rated current.................. amps
Type of connection.....sep/shunt/series/compound	Rated speed......................r.p.m
Rated voltage... volts	Protection class.........................

3 List the items you received from your instructor in Table 2.

Table 2

List of items
1 ____________________
2 ____________________
3 ____________________
4 ____________________
5 ____________________
6 ____________________
7 ____________________
8 ____________________
9 ____________________
10 ____________________

4 Record the name plate details of the contactor and overload relay in your record respectively.

5 Investigate and check the contactor input and output terminals, auxiliary and main terminals, movable and fixed contacts, no-volt coil, overload relay, their rating, normally closed relay contacts and their operation.

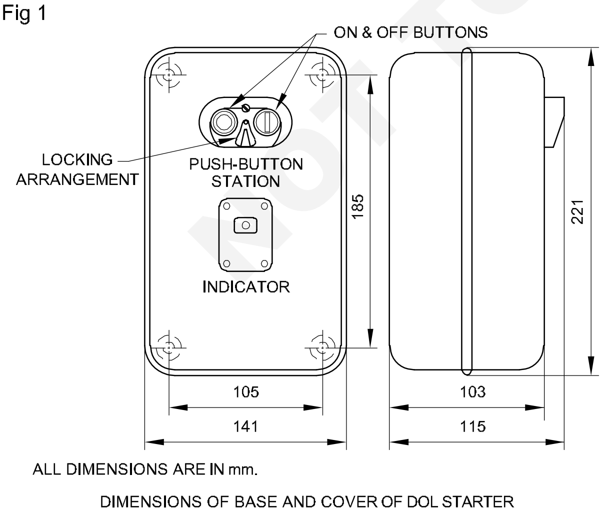
6 Identify the connecting terminals for interconnecting no-volt coil, main supply to control circuit, normally open auxiliary contacts.

Refer and recapitulate the connection diagram

7 Identify the mounting screw holes in the contactor, overload relay and the corresponding holes in the starter base box.

8 Draw the complete circuit diagram for the given D.O.L starter with overload relay, no-volt coil, 'ON' and 'OFF' push-buttons.

Fig 1



For your guidance the following diagrams are given for a starter of a particular make.

Fig 1 shows Base and cover of D.O.L starter.

Fig 2 shows Push-buttons only.

Fig 2

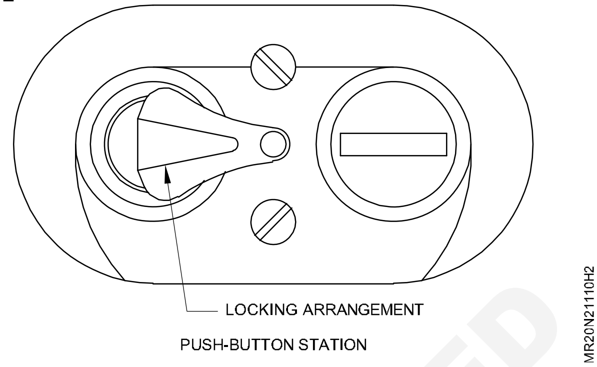


Fig 3 shows Overload relay package with push-button strips in the foreground which will get actuated when the push-buttons are pushed.

Fig 3

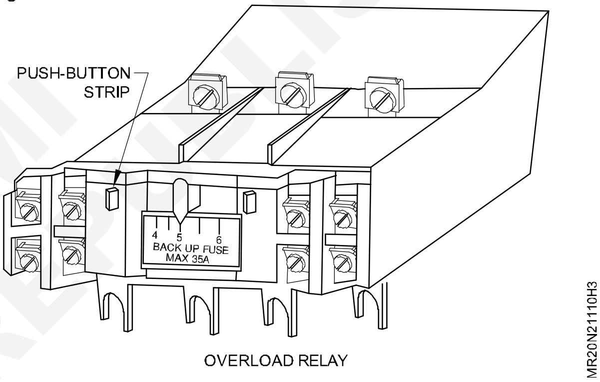
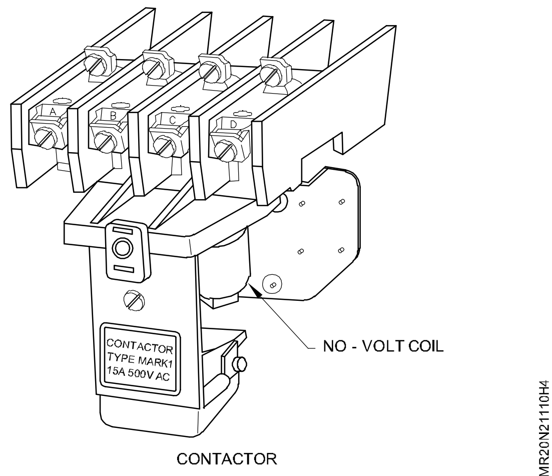


Fig 4 shows Contactor with no-volt coil.

9 Get the diagram approved by the instructor.

10 Mount the accessories in the starter base box with the help of mounting screws.

Fig 4



Do not tighten the screws more than necessary as too much tightening of screws will break the PVC casing of the contactor and OL relay.

11 Identify the place of connection of the hook-up cables with the help of the approved diagram. Measure and cut the hook-up cables leaving allowance for harnessing.

12 Connect the hook-up cables according to the approved diagram.

13 Harness the hook-up cables such that the cables do not interfere with any moving mechanism of the starter.

14 Check up once again the complete connection of the D.O.L starter internal wiring.

15 Get the wiring approved by your instructor.

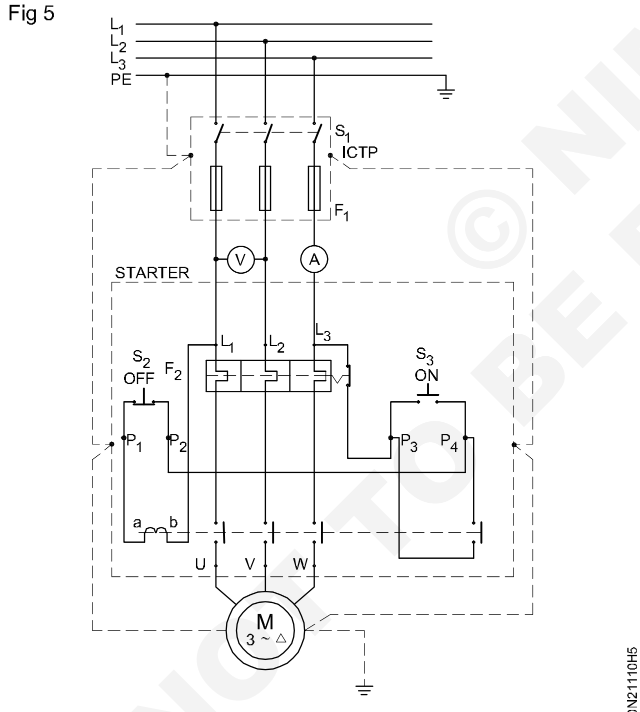
16 Identify the holes in the starter base box for mounting the starter on the wall/frame.

17 Mount the starter vertically on the wall/frame.

> **The position of the starter should be such that the no-volt coil mechanism works properly, taking advantage of the gravitational pull while disengaging.**
>
> **Use a plumb bob or spirit level to check the verticality.**

18 Connect the main supply to the starter incoming terminals through the I.C.T.P switch. (Fig 5)

Fig 5



CIRCUIT DIAGRAM OF DOL STARTER WITH PROTECTIVE DEVICE

> **A complete diagram showing the internal diagram of a starter of a particular make along with I.C.T.P and motor is given for your guidance. You can replace the internal diagram of the given starter in the place of the starter diagram shown in Fig 5.**

19 Connect the starter outgoing terminals to the 3-phase squirrel cage induction motor along with the ammeter and voltmeter as shown in Fig 5.

> **Before connecting the 3-phase squirrel cage motor, test it for continuity and insulation.**

20 Connect the protective earthling continuity conductors (two separate PE connections) to the motor and starter case, ICTP switch, and connect securely the PE continuity conductors to the main earth. (Fig 5)

21 Investigate the full load current of the motor and set the overload relay of the starter to that rating.

22 Provide a backup fuse as recommended by the manufacturer of the starter considering the horse-power rating of the motor.

> **For your guidance the backup fuse rating for a specified horsepower/kw rating.**
>
> **Preferably check for the backup fuse rating in the pamphlet supplied alongwith your starter.**

23 Get the main connections, earth connections, overload setting and the backup fuse rating approved by your instructor.

24 Switch on the ICTP.

25 Start the motor by the start (S_3) button of the starter.

26 Read the ammeter for the starting current at the time of starting.

27 Read the voltmeter and ammeter values when the motor shows normal running.

28 Measure the actual speed of the rotor with the help of a tachometer.

29 Switch OFF the motor using stop (S_2) button of the starter.

30 Switch OFF the mains, remove the fuses and disconnect the connections.

31 Determine the synchronous speed and enter the value in Table 3.

32 Show the readings to your instructor.

Table 3

S.No.	Starting Current	Volt-meter reading	Running Current	Actual Speed	Syn. Speed

Changing the direction of rotation.

1 Step the motor and note the direction of rotation when getting stopped.

2 Switch off the ICTP switch.

3 Open DOL starter front panel

4 Inter change any two phase wires in the contactor in put connection.

5 Close DOL starter front panel.

6 Switch on the ICDP switch

7 Start the motor and see the direction of rotation.

8 Note the voltage, current and speed.

9 Stop the motor and switch of ICDP switch.

— — — — — — — —

Start the motor through star - delta starter and measure starting current, running current and show changing of DOR

Objectives: At the end of this exercise you shall be able to
- **identify the parts of a manual star-delta starter and trace the connection**
- **draw the star/delta connection of motor winding through starter-handle operation**
- **connect the manual star-delta starter with 3-phase squirrel cage induction motor**
- **adjust the overload relay according to the motor current rating**
- **start the 3-phase squirrel cage induction motor through the manual star-delta starter**
- **stop the 3-phase squirrel cage induction motor through the manual star-delta starter**
- **measure two sting and running current**
- **change the DOR end and measure current.**

Requirements

Tools and Instruments

- Insulated cutting pliers 200mm - 1 No.
- Screwdriver 200mm, 300mm - 1 No.
- Side cutter 150mm - 1 No.
- Wire stripper 150mm - 1 No.
- M.I ammeter 0-10 amp - 1 No.
- M.I voltmeter 0-500V - 1 No.

Equipment/Machines

- 3-phase squirrel cage induction motor 415V, 5 HP - 1 No.
- Manual star-delta starter 16A, 415V with overload relay and no-volt coil - 1 No.

Materials

- PVC insulated, stranded aluminium, cable 2.5 sq.mm 650V grade - 25m.
- Fuse wire 10 amps - as reqd.
- Black insulation tape- - as reqd.
- ICDP switch 16A 415V - 1 No.

PROCEDURE

1 Read and interpret the name-plate details of the given 3-phase induction motor and starter and enter in Table 1

Table 1

Starter : Name Plate details

2 Switch 'off' the mains, remove the fuse-carriers and keep them in safe custody.

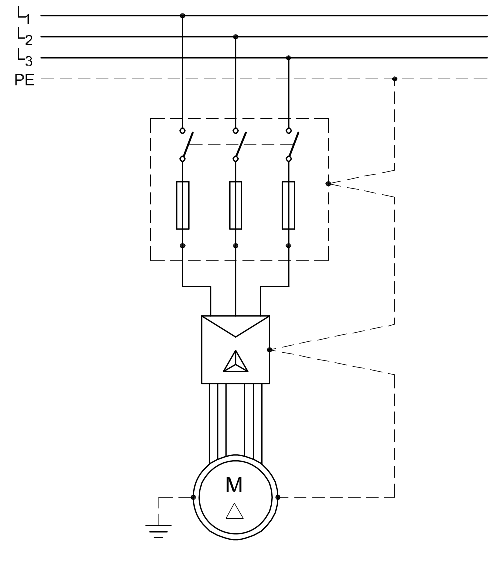
3 Remove the terminal cover of the motor and the front cover of the starter.

To connect a star-delta starter, the squirrel cage induction motor must have six terminals, which are normally marked as U_1, V_1, W_1 & U_2, V_2, W_2.

4 Identify the parts of the given star-delta starter, trace the connections and verify its operation. Draw the traced out circuit and get it approved by the instructor.

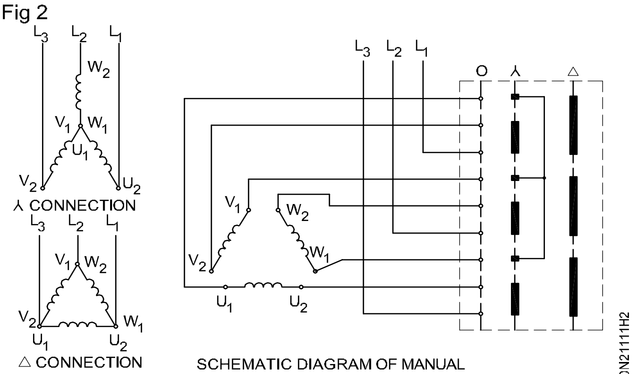
The layout diagram in Fig 1, the schematic diagram of a star-delta starter in Fig 2 and two types of practical circuits in Figs 3 and 4 are all given for your guidance only.

Fig 1



LAYOUT DIAGRAM OF STAR - DELTA STARTER CONNECTED TO THE MOTOR

Fig 2



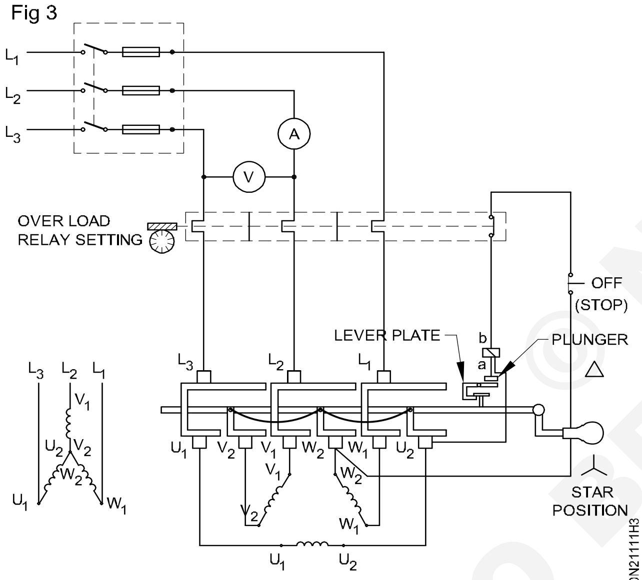
SCHEMATIC DIAGRAM OF MANUAL STAR-DELTA STARTER CONNECTIONS

5 Draw the complete connection diagram incorporating the ICTP switch, the given star-delta starter and motor and get it approved by your instructor.

6 Make the connections of the motor, starter and the ICTP switch as per the approved diagram.

7 Connect three cables from supply $L_1 L_2$ & L_3 to the main switch as shown in Fig 3 or Fig 4.

Fig 3



STAR - DELTA SWITCH IN STAR POSITION

8 Insert the ammeter in series with one of the line cables from the main switch and a voltmeter across two line cables as shown in Fig 3 or Fig 4.

9 Wire proper fuse element according to the given motor rating in the fuse-carrier and insert the carriers in the main switch.

10 Set the overload relay according to the full load current rating of the motor.

11 Provide double earth to the metal body of the main switch, starter and the motor frame.

ASSUMPTION: Check the connections for correctness and tightness. Get it approved by the instructor.

12 Switch 'on' the main, observe the voltmeter reading and move the handle to the star position positively and at the same time observe the starting current and enter it in Table 2.

13 Allow the motor to start, race initially and let the sound of the rotating shaft come to a steady state; then move the handle to the delta position positively.

14 Note down the direction of rotation and enter it in Table 3.

15 Note down the current taken by the motor in running condition and enter the value of the current in Table 2.

16 Then stop the motor by pressing the stop-button of the starter.

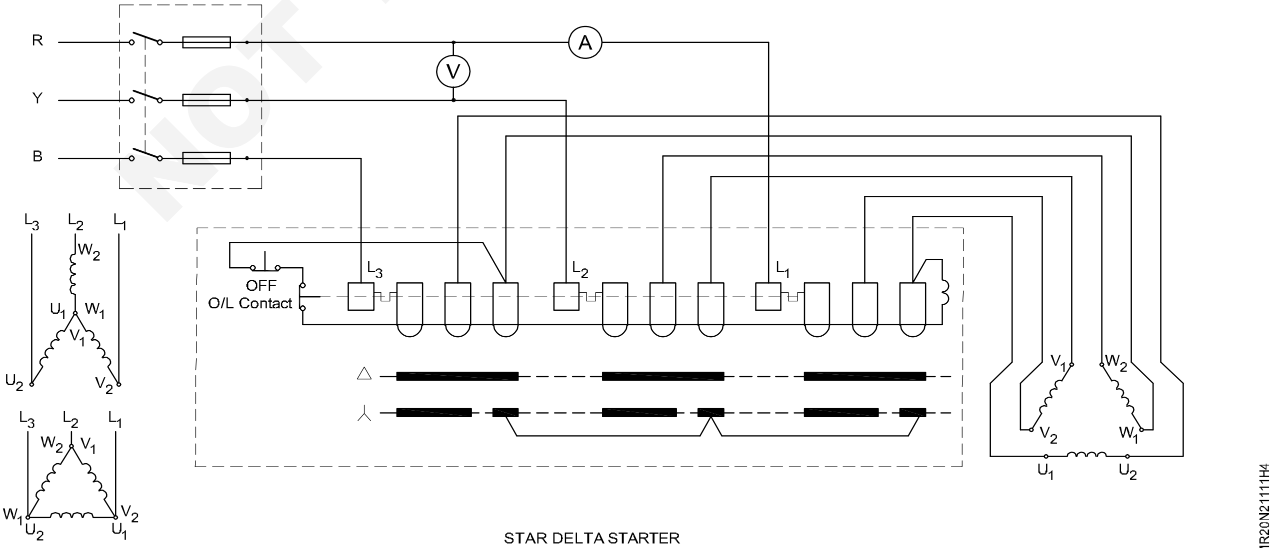
17 Switch 'OFF' the main switch and remove the fuses.

18 Interchange the two line cables R' and Y' to terminals L_2 and L_1 respectively as shown in Fig 5.

19 Insert the fuse-carriers in the main switch.

20 Repeat steps No.12 to 15 and record the information in Tables 3 and 4.

Fig 4



STAR DELTA STARTER

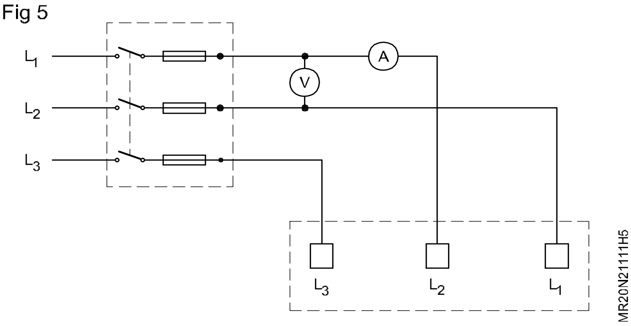
Table 2

Sl. No.	Description	1st Start	2nd Start	3rd Start	Unit
1	Supply voltage				Volts
2	Starting current (Star position)				Amps
3	Running current (Delta position)				Amps

Table 3

Sl.No.	Description	Direction of rotation
1	1st start Connection R to L_1 Y to L_2 B to L_3	
2	2nd start Connection R to L_2 Y to L_1 B to L_3	
3	3rd start Connection R to L_2 Y to L_3 B to L_1	

Fig 5



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Start the motor through auto-transformer starter operated by contactors

Objectives: At the end of this exercise you shall be able to
- **connect a 3-phase induction motor with an auto-transformer and contactors as starter**
- **start and run a 3-phase induction motor by auto-transformer and contactors.**

Requirements

Tools and Instruments

- Multimeter - 1 No.
- Megger 500V - 1 No.

Equipment/Machines

- Auto-transformer starter 3-phase 415V with tapping - 1 No.
- AC 3-phase squirrel cage induction motor 415V, 3KW/5HP - 1 No.

Materials

- Contactors 415V, AC with 240V operating coil having 16A - 3 power circuit contacts 2A - 4 auxiliary change over contacts - 4 Nos.
- Delay time relay, 24V, AC operating coil with 1 or 2 normally open contacts - 3 Nos.
- Connecting cable copper 1.5mm^2 for control circuit - 10m
- Power cable single strand 2.5mm^2 copper - as reqd.

PROCEDURE

1 Check the insulation and continuity of three-phase induction motor.

2 Check the earthling connection for its effectiveness.

3 Trace the diagrams Fig 1 and 2.

4 Draw the power lines connecting the contactors, auto-transformer and motor for sequential operation as in Fig 3.

5 Mark the different terminals of contactors corresponding to the actual panel provided.

6 Draw the control circuit connections including timer and overload trip for sequential operation in Fig 3.

7 Complete the connections external to the panel in Fig 3.

Get the circuit checked by the instructor before proceeding.

8 Make connections as per diagram.

9 Switch 'ON' S1. Switch 'ON' the contactor.

Fig 1

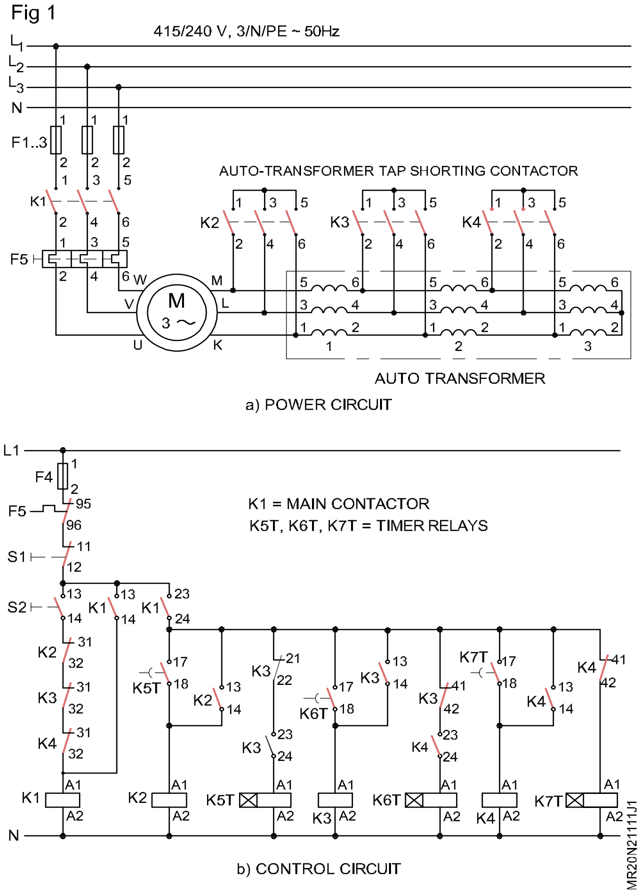
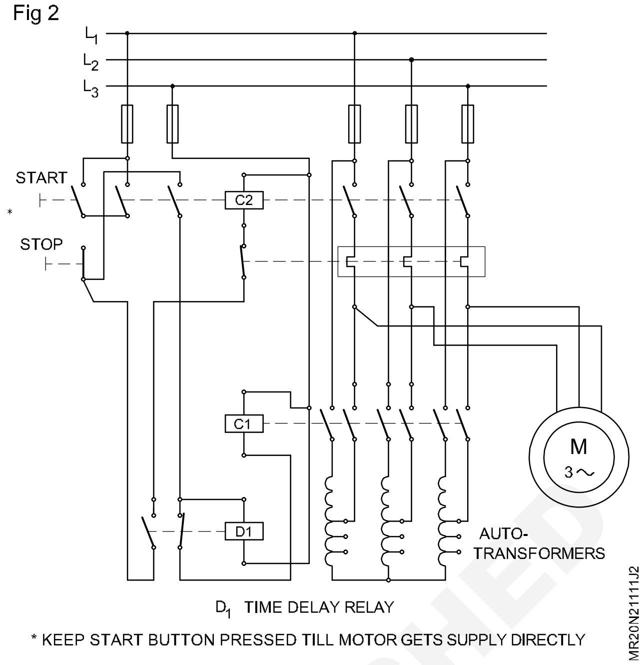


Fig 2

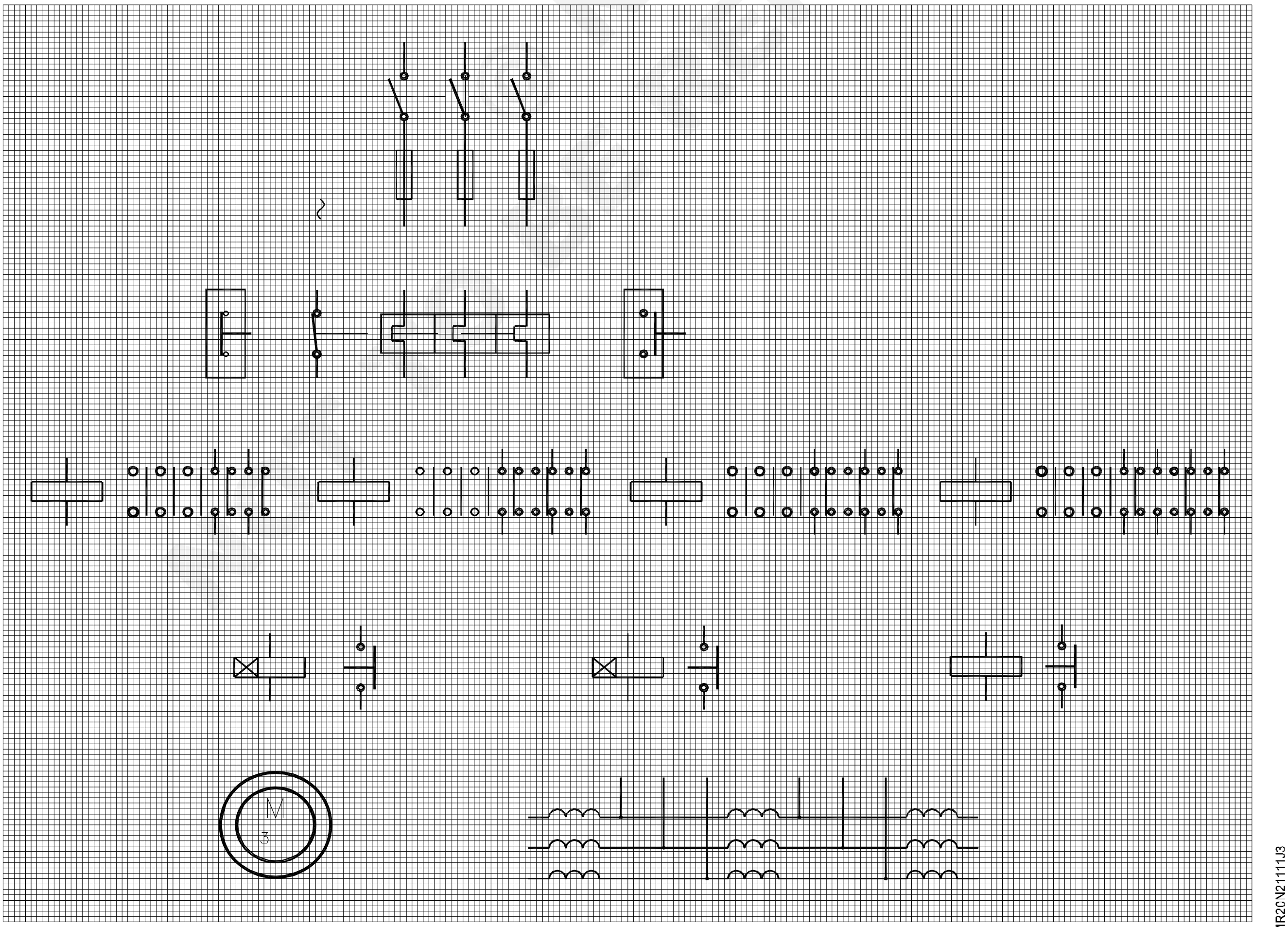


10 Check when the full voltage to the induction motor is given by the auto-transformer.

11 Measure rpm of the induction motor.

12 Switch 'OFF' the contactor and then the S_1.

Fig 3



Familiarise with slipring induction motor and identify its terminals

Objectives: At the end of this exercise you shall be able to
- **read and interpret the name-plate details of a 3-phase slip-ring induction motor**
- **identify the slip ring motor**
- **identify the terminals of 3-phase slip-ring induction motor**

Requirements

Tools and Instruments

- Insulated cutting pliers 200mm - 1 No
- Connector screwdriver 100mm - 1 No
- Electrician's knife - 1 No
- Screwdriver 200mm - 1 No
- Voltmeter (MI 0-500V) - 1 No
- Tachometer 300 r.p.m to 3000 r.p.m - 1 No
- Ammeter MI (0-20A) - 1 No
- Megger 500V - 1 No

Equipment/Machines

- AC 3-phase, slip-ring motor 415V 5HP - 1 No
- Rotor resistance starter, complete set, suitable for 5HP 415V 3-phase, slip-ring induction motor - 1 No

Materials

- PVC insulated, stranded aluminium cable 2.5 sq.mm - 15m
- PVC insulated, flexible cable 14/0.2mm - 2m
- Black insulation tape - 0.2m
- G.I. wire 8 SWG - 10m

PROCEDURE

TASK 1: **Connect the slip-ring motor**

1 Record the name-plate details of the given motor and the starter, and enter them in Tables 1 and 2 respectively.

Table 1
Name-plate details

Manufacturer, Trade Mark..	Rated frequency......................
Type, model or list number.......................................	Rated power.............k.w/HP
Type of current..	Rating class......................
Function..........................	Insulation class..................
Fabrication or serial number.....................................	Rated current......... amps
Type of connection.....sep/shunt/series/compound	Rated speed...........r.p.m
Rated voltage................ volts	Protection class...........

Table 2
Name-plate details

Manufacturer co:____	
Voltage_______	No Phase__________
Current______	HP/KW____________
P.F._________	Rotor resistance/phase____
Serial No._____	Type__________
No. of steps_______	Total resistance per phase __________
Starting current___	Max. current_________
Serial No.______	Type of starter_______

Start the slip-ring induction motor through rotor resistance starter and measure starting current, running current and show changing of DOR

Objectives: At the end of this exercise you shall be able to
- **identify the parts of a rotor resistance starter, trace the circuit and investigate the operation**
- **connect the 3-phase, slip-ring induction motor through the rotor resistance starter, start and run the motor**
- **measure the starting and running current and speed**
- **reverse the direction of rotation.**

Requirements

Tools and Instruments

- Insulated cutting pliers 200mm - 1 No
- Connector screwdriver 100mm - 1 No
- Electrician's knife - 1 No
- Screwdriver 200mm - 1 No
- Voltmeter (MI 0-500V) - 1 No
- Tachometer 300 r.p.m to 3000 r.p.m - 1 No
- Ammeter MI (0-20A) - 1 No
- Megger 500V - 1 No

Equipment/Machines

- AC 3-phase, slip-ring motor 415V 5HP - 1 No
- Rotor resistance starter, complete set, suitable for 5HP 415V 3-phase, slip-ring induction motor - 1 No

Materials

- PVC insulated, stranded aluminium cable 2.5 sq.mm - 15m
- PVC insulated, flexible cable 14/0.2mm - 2m
- Black insulation tape - 0.2m
- G.I. wire 8 SWG - 10m

PROCEDURE

1 Identify the terminals of the 3-phase, slip-ring induction motor terminals.

Slip-ring terminals can be identified by checking the continuity from terminals to the slip-ring.

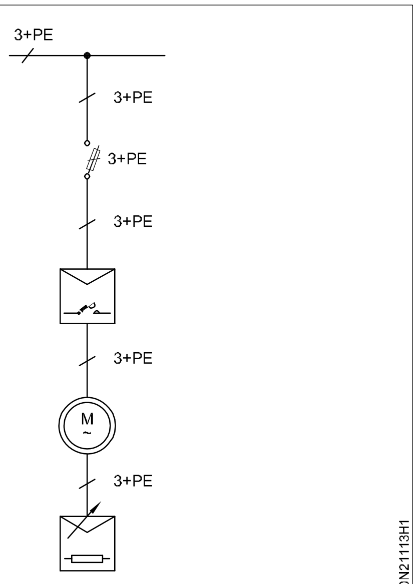
2 Open, identify and trace the internal connections of the rotor resistance starter, draw the diagram and get it approved by the instructor.

Fig 1 gives the layout, Fig 2 gives the power circuit connection diagram, Fig 3 gives the control circuit diagram, and Fig 4 gives the generalised circuit diagram of a rotor resistance starter. Compare it with the traced-out diagram.

3 Select the ICTP switch, cables and fuse-wire according to the rating of the motor.

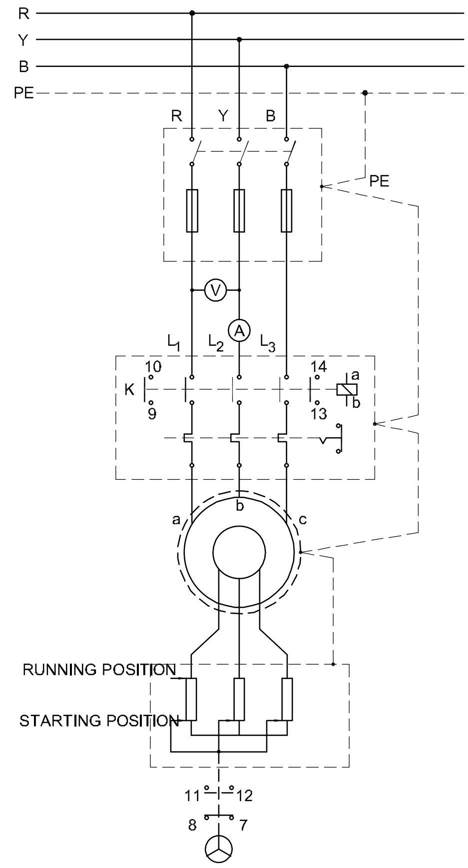
4 Draw the circuit diagram connecting the ICTP, starter, rotor-resistance and the motor, and get it approved by the instructor.

Fig 1



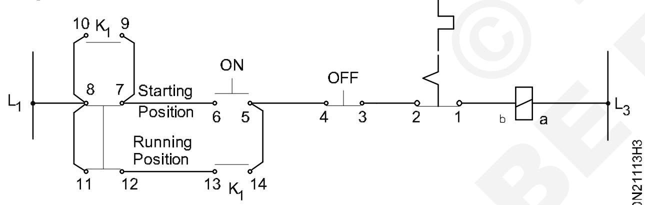
LAYOUT DIAGRAM

Fig 2



POWER CIRCUIT CONNECTION DIAGRAM

Fig 3



CONTROL CIRCUIT DIAGRAM

Fig 4 is given to you for your guidance. There may be variations in the practical circuit.

5 Connect double earth independently for the main switch starter and the motor. (Use G.I wire No.8 SWG as earth wire)

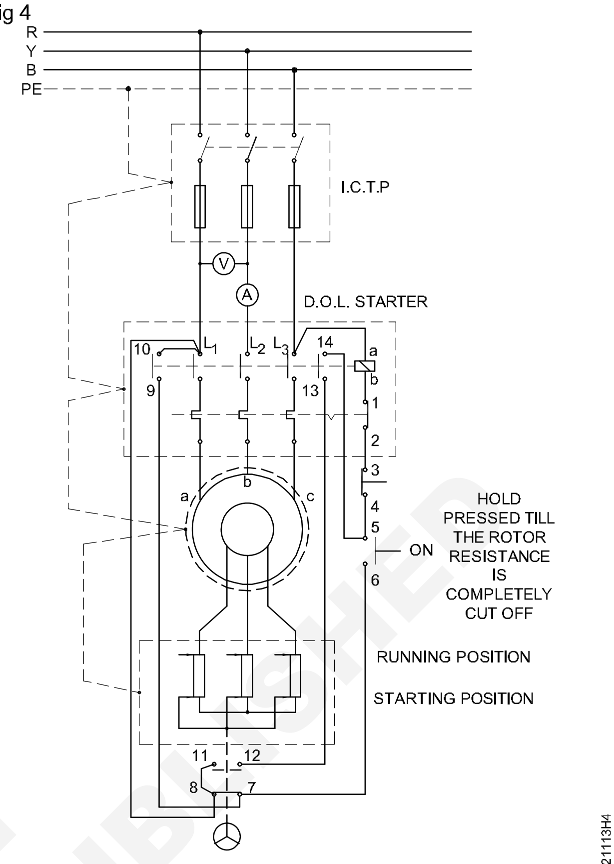
6 Connect the motor, starter, main switch meters as per the approved diagram and get it checked by the instructor.

7 Check the supply and provide proper rating fuses in the main switch according to the motor rating.

To start and run the motor

8 Keep the rotor resistance starter handle in the starting position (cut in) of the rotor resistance.

Fig 4



CIRCUIT DIAGRAM OF THE ROTOR RESISTANCE STARTER WITH I.C.T.P. SWITCH & MOTOR

'Cut in' position of the rotor resistance is generally indicated in the starter as 'starting position' or 'off position'.

9 Press the start-push button of the starter. While pressing the start-push button, slowly move the handle of the rotor resistance from the starting position towards the running position till it settles down at 'run' position.

10 Note down the reading of the voltmeter, ammeter at the time of just starting and normal running positions. Record them in Table 3.

11 Release the pressure from the start-push button.

12 Note down the direction of rotation. The direction of rotation is ....

13 Measure the speed and enter in Table 3.

14 Press the 'OFF' button of the starter to stop the motor.

15 Try to start the motor when the rotor-resistance handle is in the running position. The motor starts only when the rotor-resistance handle is in the starting position. (Fig 4) The motor will not start in any intermediate position or in the running position.

Table 3

(L with air gap)

Measured resistance = ...ohms

Sl. No.	Line voltage in volts	Starting current in amp	Running current in amp	Full load current as shown in the name-plate in amps	Speed

Investigate the following

– Whether the motor could be started when the rotor resistance handle is at the running position.

– Whether the motor could be started when the rotor resistance handle is at an intermediate position between the starting and running positions.

– Whether the motor could be started when the rotor resistance handle is at the starting position.

Write your conclusion.

____

____

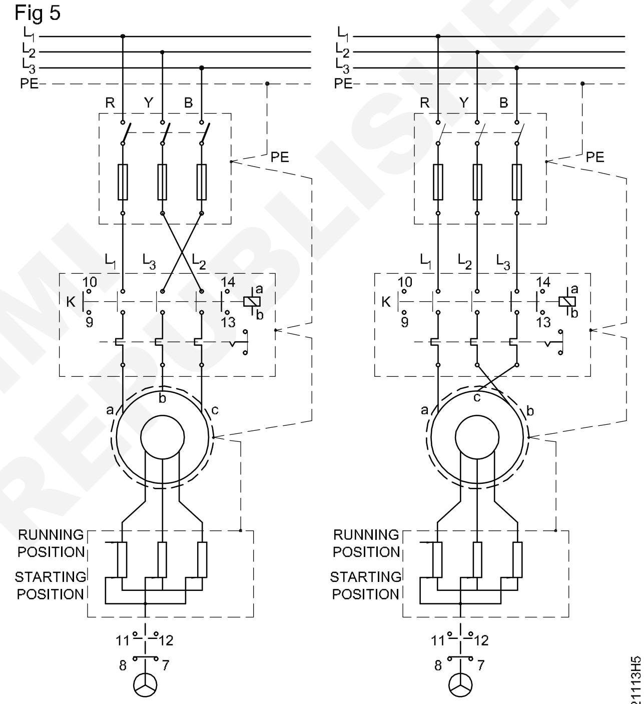
16 Switch OFF the ICTP and make sure the supply is disconnected, and the fuses are removed and kept in safe custody.

17 Interchange any two of the line wires, either in the starter terminal as shown in Fig 5a or in the motor terminals as shown in Fig 5b.

Change either the outgoing cable of ICTP of the incoming cables of the starter, whichever is easier.

18 Replace the fuses, switch 'ON' the mains and run the motor, observe and record the direction of rotation. The direction of rotation is ....

Fig 5



(a) TO CHANGE THE DIRECTION OF ROTATION OF THE STEP RING MOTOR

(b) TO CHANGE THE DIRECTION OF ROTATION OF THE STEP RING MOTOR

19 Stop the motor, switch 'off' the mains, remove the fuses and disconnect the cables.

— — — — — — — —

Rectify fault through insulation test continuing the open circuit test and short circuit test

Objectives: At the end of this exercise you shall be able to
- **identify the terminals of the slip ring induction motor (R)**
- **perform insulation resistance test between phase windings (Task 1)**
- **perform insulation resistance test between winding and body (Task 2).**

Requirements

Tools and Instruments

- D.E spanner 5mm to 20mm - 1 set
- Cutting pliers 200mm - 1 No
- Screwdriver 200mm - 1 No
- Megger 500V - 1 No
- Ohmmeter low range 0-10 ohm - 1 No
- Test lamp 230V, 60W - 1 No
- Earth tester with spikes and connecting leads - 1 set
- Hammer straight peen 1.5kg - 1 No
- M.C voltmeter 0-10V - 1 No
- M.C ammeter 0-20A - 1 No
- Calibrated rheostat 0.1 ohm, 10 amp - 1 No
- Battery 6V, 60 AH - 1 No
- M.I voltmeter 0-50V - 1 No
- M.I voltmeter 0-25A - 1 No

Equipment/Machines

- AC 3-phase, 415V squirrel cage induction motor - as available

Materials

- Connecting cables 70/0.2 of length 40m - 1 No
- Connecting cables 70/0.2 of length 10m - 1 No
- Testing prods - 1 pair

PROCEDURE

TASK 1: **Measure the insulation resistance value between the windings.**

> **Before starting the Megger test, see that the supply is off, fuse-carriers are removed and the motor is disconnected from the starter.**

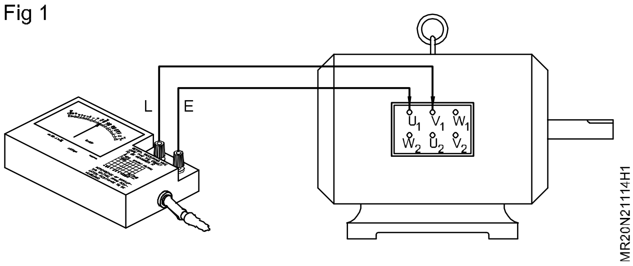
1 Identify the terminals of the given Slip ring induction motor from the markings.

> **As a precautionary measure, remove all the links in the terminal plate and check the continuity of each winding. End terminals of the same winding should have continuity.**

2 Connect the test leads of the Megger as shown in Fig 1, to the terminals U_1 and V_1.

3 Rotate the Megger at its rated speed and note down the readings in Table 1.

Fig 1



4 Repeat the steps 3 and 4 by connecting the Megger terminals between U_1 and W_1, and also between V_1 and W_1. Record the findings in Table 1.

Recommended standard insulation resistance

$R_1 = \frac{20 \times E\eta}{1000 + 2P}$ in megohm Eqn.1

where

R_1 = insulation resistance in megohms at 25^0C.

E_n = rated phase-to-phase voltage

P = Rated power in kW.

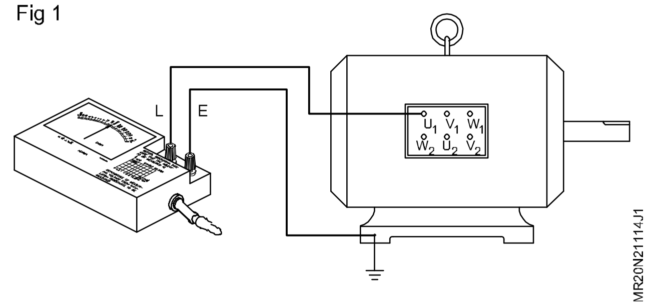
If the resistance is measured at a temperature different from 25^0C, the value shall be corrected to 25^0C.

> **The equation 1 given here is used to calculate the insulation resistance as a standard value. However the accepted insulation value should not be less than 1 meg ohm.**

TASK 2: **Measure the insulation resistance between each winding and body or frame**

1 Connect the test leads of the Megger to the frame of the motor and terminal U_1 as shown in Fig 1.

Fig 1



The Megger connection to the frame should be done at the earthing stud of the frame. Before connecting, remove the varnish, dust, dirt and grit thoroughly at the earthing stud.

2 Rotate the Megger at its rated speed and note down the readings in Table 1.

3 Repeat steps 1 and 2 for the other two windings (V_1 and W_1).

4 Compare the measured value with the standard value.

The above test will not be valid until and unless the following conditions are observed.

CONDITION b1

Check and ensure that the earth continuity conductor (E.C.C) connected to the main earth electrode is in perfect continuity, having a resistance of less than 1 ohm.

CONDITION b2

The resistance of the earth electrode should be less than 5 ohm unless otherwise stated.

Table 1

Insulation resistance of 3-phase induction motor

Sl. No.	Between terminals	Insulation resistance	Remarks
1	U_1 and V_1		
2	U_1 and W_1		
3	V_1 and W_1		
4	U_1 and frame		
5	V_1 and frame		
6	W_1 and frame		

Continuity test

- Identify the three windings by lettering U_1 U_2, V_1 V_2 & W_1 W_2 .
- Touch ohm meter ponds to U, and U_2 and see the vending it meter shows vending continuity is ok.
- Do the same thing to V_1 and V_2, W_1 and W_2.

Open circuit test

- Do the same thing like continuity test. it the meter show intensify the winding is open.

Shirt circuit test

- Do the same thing like continuity test, it the meter shows 'O' ohm the winding is short circuit.

Service water cooled condenser and receiver

Objectives: At the end of this exercise you shall be able to
- **identify the parts of a shell and tube condenser**
- **check the condenser and ensure of the condenser reeds descaling**
- **pump down the system**
- **descale the condenser with brush**
- **service liquid receiver.**

Requirements

Tools/Instruments

- Centre punch - 1 No.
- Valve key - 1 No.
- Double end spanner 6mm to 27mm - 1 Set.
- Pipe wrench - 1 No.
- Chisel 6” - 1 No.
- Hammer - 1 No.
- Compound gauge, pressure gauge - 1 Set.

Equipment/Machines

- Commercial refrigeration system - 1 No.
- Water cooled condenser shell and tube (Capacity 5 TR) - 1 No.

Materials

- Tube expander - 1 No.
- Bottle corks to tube 1D (rubber) - as reqd.
- Pressure gauge 0.10 Kg/cm^2 - 2 Nos.
- Teflon tape - 1 No.
- 3.00 mm thick rubber sheet - as reqd.
- Water service valve - as reqd.
- Gate valve - 1 No.
- Globe valve - 1 No.
- Brass tube cleaning brush - 1 No.
- Flexible hoses and hose clamps - as reqd.
- Litmus paper 0-14 PH - 1 Set.

Hints to Instructor : Before commencement of this exercise, Instructor has to label the parts of shell and tube condenser.

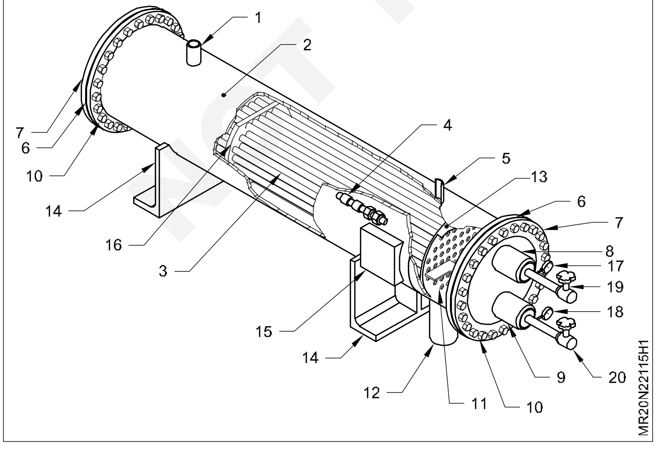
PROCEDURE

TASK 1 : **Identify the parts of a shell and tube condenser**

1 Identify the parts name of a shell and tube condenser. (Fig 1)

2 Record in the Table 1 of record sheet.

Fig 1



Record sheet

Table 1 : Water cooled condenser

Label	Name of the parts identified
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

Table 2 : Condenser design data

Make	
Type	
Capacity	
Type of refrigerant used	
Operating pressure shell side	
Operating pressure tube side	
Test pressure shell side	
Test pressure tub side	
Tube side water pressure	
Shell side gas pressure	
Tube side water pressure drop	
Cooling water flow quantity	
Liquid refrigerant hold up quantity	

— — — — — — — —

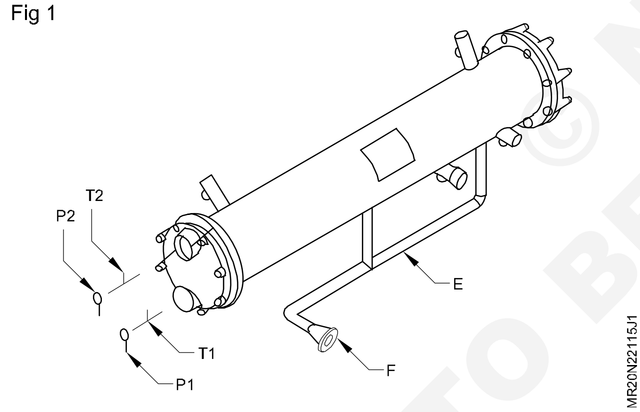
TASK 2 : **Check the condenser and ensure if the condenser needs de-scaling (Fig 1)**

1 Switch 'ON' the power supply.

2 Open the condenser and chilled water valves.

3 Start necessary auxiliaries.

Fig 1



4 Open the suction and discharge valves of compressor.

5 Start the compressor.

6 Observe the suction and delivery pressures on the gauge panel.

7 If the delivery pressure is above normal.

8 Check the liquid line outlet pipe outer surface temperature with your palm.

9 It should be slightly higher than ambient temperature.

10 Check the condenser inlet and outlet water temperature, the outlet temperature should read 5°C higher than the in let fit reads lesser.

11 Then the condenser needs de-scaling.

12 Refer Fig 2 and Record Sheet.

Record Sheet

P1	
P2	
T1	
T2	

— — — — — — — —

TASK 3 : **Pump down the system**

1 Put off the system.

2 Close the liquid line.

3 Bypass the electrical connection at low pressure cut out switch.

4 Start the compressor drive motor.

5 Watch and wait till the suction pressure drops to 0.5 kg/sq.cm.

6 Stop the compressor - drive motor.

7 Immediately close the delivery (Discharge) valve.

Precaution : Do not allow the compressor suction pressure drop to vacuum or allow oil to pump to the system.

— — — — — — — —

TASK 4 : **De-scale the condenser with wire brush**

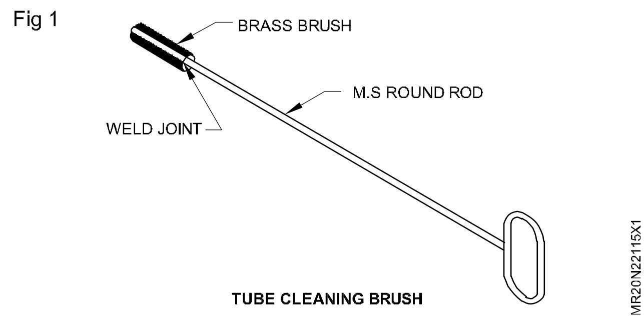
1 Put off the compressor and main power supply. Close the cooling water outlet and inlet valve.

2 Drain the water from the condenser through drain plug.

3 Punch mark the end cover with reference to tube sheet outer.

4 Loosen the water line flanges and end covers retaining bolts.

Fig 1

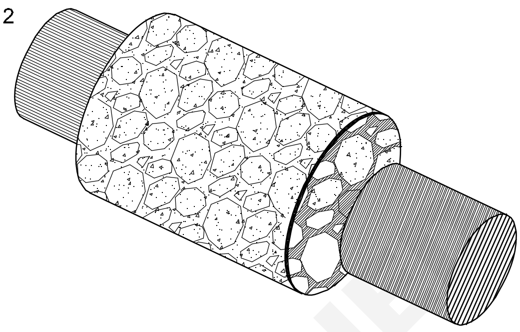


5 Remove the end cover. Do not damage the gasket.

6 Clean each tube thoroughly with a soft brass tube cleaning brush which is welded to the rod. (Fig 1)

7 Use soft brush for finishing after clean with wire brush Fig 2.

Fig 2



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TASK 5 : **Service liquid receiver**

1 Identify the liquid receiver with all accessories. (Refer related theory)

2 Clean the unit with dry cloth

3 Check the sight glass. For visibility of liquid level

4 Check proper functioning of safety valve, relief valve and service valve.

5 Check proper functioning of pressure gauges.

— — — — — — — —

Test performance of water cooled condenser, inlet and outlet pressure and temperature

Objectives: At the end of this exercise you shall be able to
- **check and calculate differential water pressure**
- **test the performance of water cooled condenser.**

Requirements

Tools/Instruments

- Digital thermometer - 1 No.
- Pressure gauge - 1 No.

Equipment/Machines

- Water cooled condenser shell and tube in unit (Capacity 5 TR) - 1 No.

Materials

- Teflon tape - 1 No.
- 3.00 mm thick rubber sheet - as reqd.
- Water service valve - as reqd.
- Gate valve - 1 No.
- Globe valve - 1 No.

Hints to Instructor : Before commencement of this exercise, Instructor has to label the parts of shell and tube condenser.

PROCEDURE

TASK 1 : **Check the water flow and calculate differential pressure (Fig 1)**

1 Open water valves of inlet and outlet of the condensor.

2 Check condenser inlet and outlet pressure gauge readings and record in the record sheet.

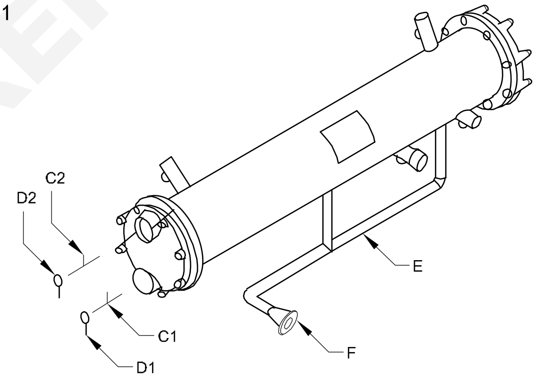
3 Inlet pressure gauge reading = 2.0 kg/cm$^{2.}$

Outlet pressure gauge reading = 1.0 kg/cm^{2}.

(Difference of pressure) =1.0kg. Reading (DeltaP) = 1.0 kg

The difference should be 0.5 kg/cm^{2} to 1.0 kg/cm^{2} i.e. the outlet pressure gauge should read 0.6 to 1.0 kg lower than the supply pressure gauge.

Fig 1



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TASK 2: **Test the performance of water cooled condenser**

1 Switch 'ON' the power supply

2 Open the condenser and chilled water valves

3 Start necessary auxiliaries

4 Open the suction and discharge valves of compressor

5 Start the compressor

6 Observe the suction and delivery pressures on the gauge panel.

7 If the delivery pressure is above normal.

8 Check the liquid line outlet pipe outer surface temperature with your palm.

9 It should be slightly higher than ambient temperature.

10 Check the condenser inlet and outlet water temperature, the outlet temperature should read 5°C higher than the inlet. If it reads lesser.

11 Then the condenser needs de-scaling.

— — — — — — — —

De-scale the shell and tube condenser by diluted HCI

Objectives: At the end of this exercise you shall be able to
- **de-scale the condenser with diluted HCI**
- **maintain safety measures (when de-scaling).**

Requirements

Tools/Instruments

- Double end spanner 6mm to 27mm - 1 Set.
- Screw driver 12" (300mm) - 1 No.
- Cutting plier - 1 No.
- Centre punch - 1 No.

Equipment/Machines

- Shell & tube condenser (Capacity 5 TR) - 1 No.
- De-scaling pump set with mixing tank - 1 No.

Materials

- Flexible hoses (acid resistance)
- Hose clamps - as reqd.
- Litmus paper 0-14 pH - 1 Set.
- HCl - as reqd.
- Inhibition - 1 No.

PROCEDURE

TASK 1 : **De-scale the condenser with diluted HCI**

1 Connect the acid circulating system to the condenser as shown in Fig.1.

2 Fill the mixing tank with clean water up to 3/4 level.

3 Connect the acid circulating pump motor to power supply.

4 Open pump suction and delivery and vent valves.

5 Start the pump and keep filling the mixing tank maintain 1/2 level till the water returns back to the tank through vent line.

6 Stop clean water filling

7 Calculate roughly the water up quantity in the system.

8 Add commercial grade hydrochloric acid to the mixing tank to the required quantity to maintain 5 percent of solution (i.e.) water and acid in the mixing tank.

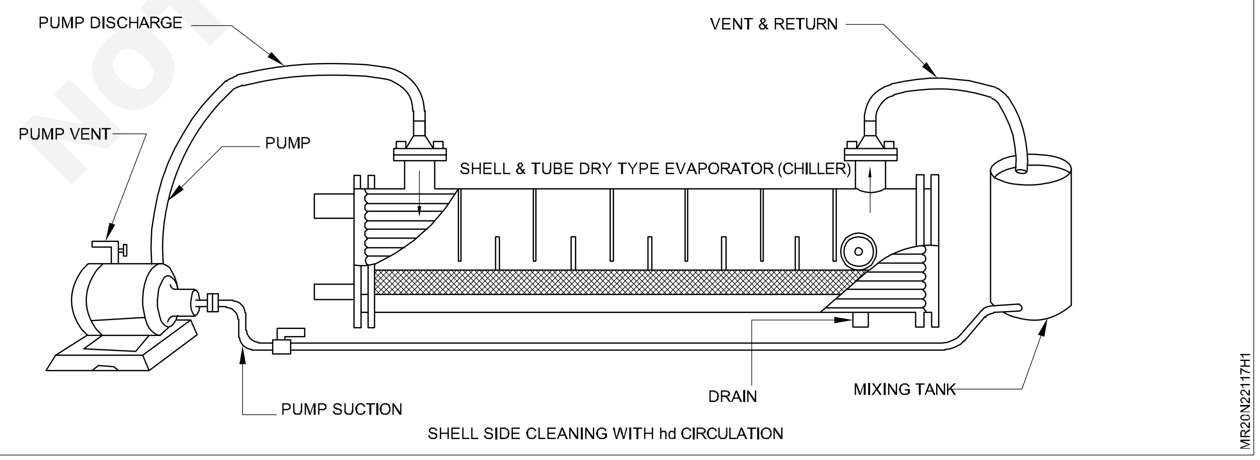
Add inhibitor to the solution in the mixing tank refer manufacturer's details on the inhibitor container for quantity.

9 Circulate for 4 hours after completion of 4 hours connect the return vent line to a movable barrel which could hold the total hold up quantity.

10 Drain the system quantity to the barrel by operating the pump.

Do not run the pump dry.

Fig 1



SHELL SIDE CLEANING WITH hd CIRCULATION

11 Fill the mixing tank with fresh water and circulate. Check the pH value of return water till it raise 7-7.5 water to the be added if it reads lower value of pH.

12 Stop the circulation

13 Drain the mixing tank and hold up water to a area outside the building.

14 Shift the movable barrel with the 5 per cent de scaling solution to a safe place outside. Pour it down and pour fresh water (or pour in the running water canal).

15 Disconnect the de scaling system.

— — — — — — — —

TASK 2 : **Maintain safety measures (Fig 1A & Fig 1B)**

1 Always add acid to water but not water to acid.

2 Wear goggles.

3 Wear gloves.

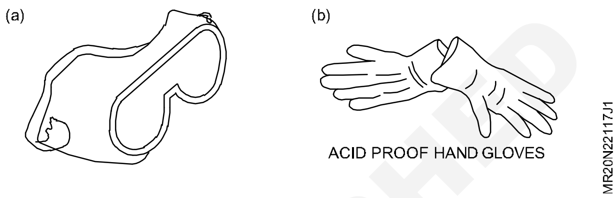
4 Ensure that all joints are full tight.

5 Do not allow the acid de scaling system tank to overflow.

6 Pour out the 5 per cent de scaling solution from movable barrel to isolated place or in a huge canal of flowing water.

7 Ensure that the welding joint from brush to rod is ground smooth and it should be of the rod dia.

Fig 1



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Pump down the gas for necessary servicing and repair

Objectives: At the end of this exercise you shall be able to
- **pump down the compressor**
- **pump down the system.**

Requirements

Tools/Instruments

- Valve key (handle) - 1 No.
- Double end spanner set - 1 No.

Equipment/Machines

- Compound gauge, pressure gauge attached to operating panel - 1 Set

Materials

- Commercial open type Compressor system - 1 Set

PROCEDURE

TASK 1: **Pump down the compressor**

Ensure the plant is idle, if it is running, with the instruction of Instructor.

1 Put off the system.

2 Close the suction (service) isolating valve.

3 Bypass the electrical connection at low pressure cutout switch.

4 Start the compressor drive motor.

5 Watch and wait till the suction pressure drops to 0.5 kg./sq.cm.

6 Stop the compressor - drive motor.

7 Immediately close the delivery (discharge) valve.

8 Open the suction gauge port and vent the least gas pressure from the compressor.

Precaution : Do not allow the compressor suction pressure drop to vacuum, or allow oil to pump to the system.

— — — — — — — —

TASK 2: **Pump down the system**

1 Put off the system, if it is running.

2 Bypass the electrical connection at the low pressure cutout switch.

3 Close the (king valve) liquid line shut off valve.

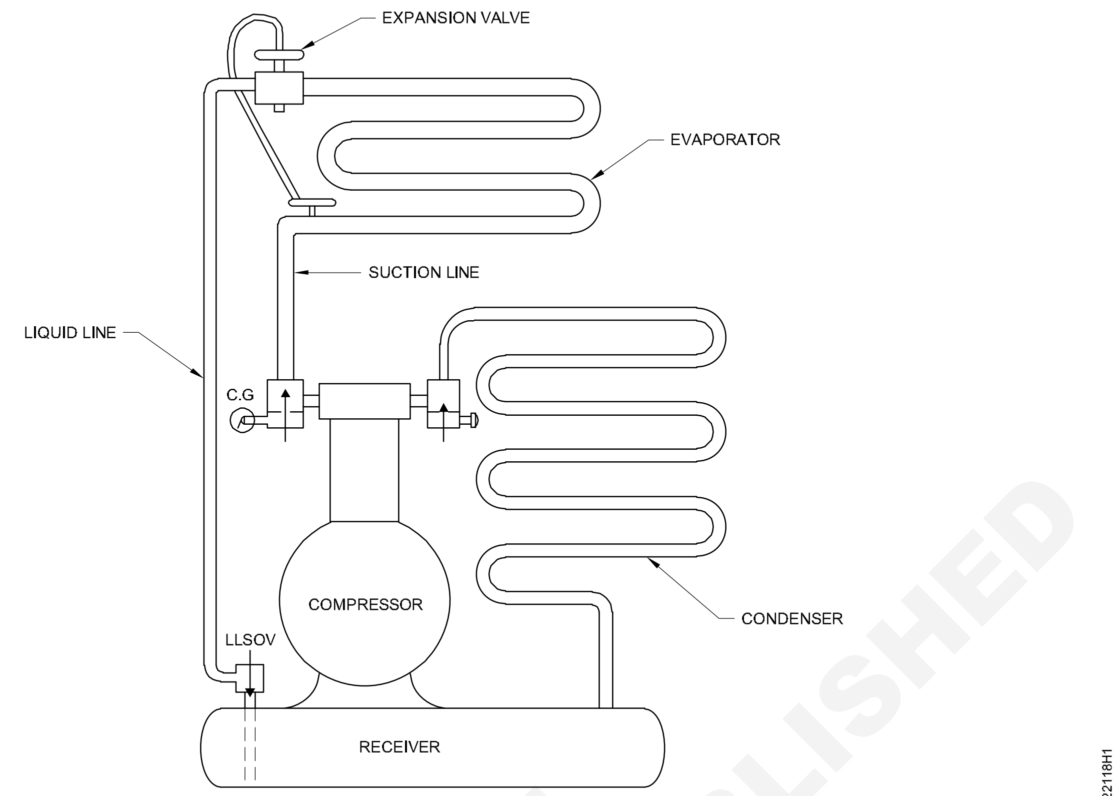
4 Start the compressor and watch the suction valve gauge pressure drops till 0.5 kg/sq.cm.

5 Stop the compressor and close the discharge valve. (Refer Fig 1) Transferring refrigerant to the receiver.

Precaution: Ensure the water flow in the water cooled condenser.

Read the Related Theory

Fig 1



TRANSFERING REFRIGERANT TO THE RECEIVER

— — — — — — — —

Service natural draft, forced draft and induced draft cooling tower

Objectives: At the end of this exercise you shall be able to
- **identify the parts of natural draft cooling tower**
- **service natural draft cooling tower**
- **identify the parts of forced draft cooling tower**
- **service forced draft cooling tower**
- **identify induced draft cooling tower**
- **service induced draft cooling tower.**

Requirements

Tools/Instruments

- Chisel 150 mm - 1 No.
- Wire brush 250 mm - 1 No.
- Pipe wrench 150 mm - 1 No.
- Combination plier 150 mm - 1 No.
- Double end spanner (6mm to 24mm) - 1 Set.
- Adjustable wrench - 1 No.
- Screw driver (10mm tip, 200mm long) - 1 No.
- Ball pein hammer - 1 No.

Equipment/Machines

- Commercial refrigeration or air conditioning plant using natural draft, forced draft and induced draft cooling tower - 1 No each.

Materials

- Colour paints (as per pipe line, channels, colour code) - as reqd.
- Anti corrosive paint - as reqd.
- Wire brush, painting brush - 1 No.
- Clean cloth G.I. sheet bits - as reqd.
- Shovel and bond - as reqd.
- Kerosene oil - as reqd.

PROCEDURE

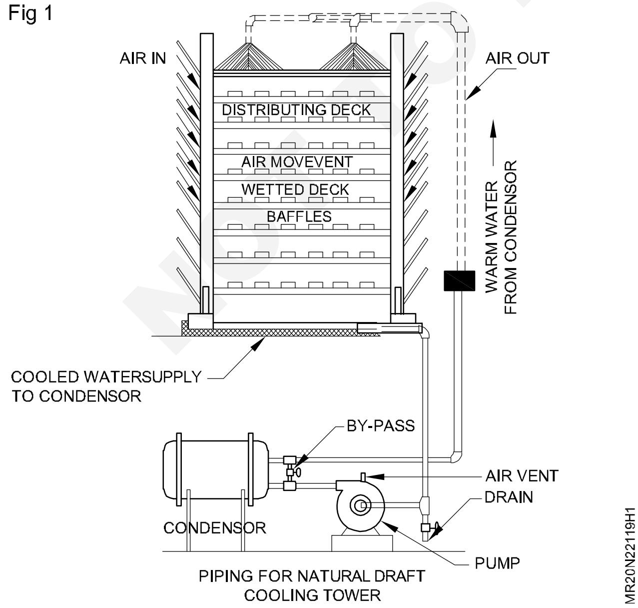
TASK 1 : **Identify the parts of natural draft cooling tower**

1 Stop the plant.

2 Close water line valves

3 Observe the parts in water circulation system.

Fig 1



4 Observe the parts of cooling tower and record it in Table 1.

TABLE 1

Sl. No.	Name of the parts	Location
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

— — — — — — — —

TASK 2 : **Service natural draft cooling tower**

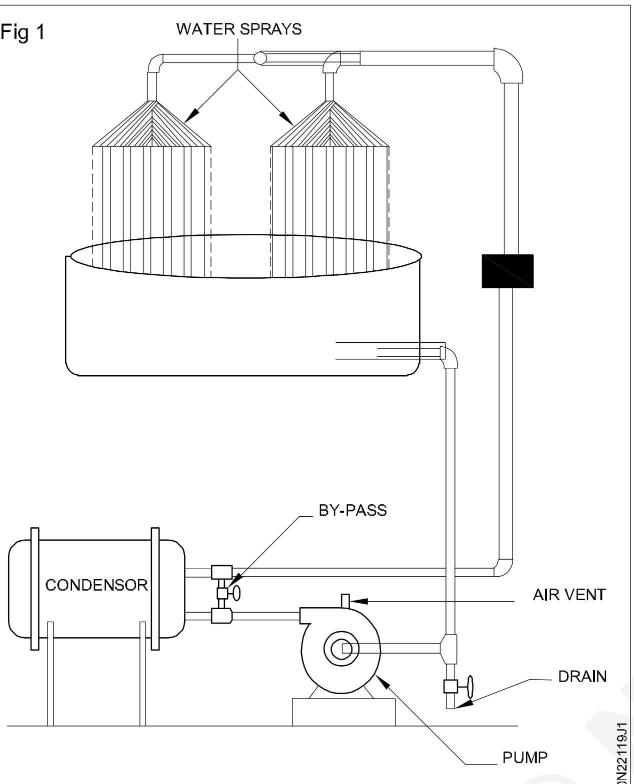
Check the water spray (Fig 1)

1 Open the inlet and out valve.

2 Energise the water circulating pump

3 Observe the water spray through nozzles.

Fig 1



CHECKING OF WATER SPRAY THROUGH NOZZLES

Clean in spray nozzles

Clean the louvers

1 Spray forced water on each louvers

2 Rub with brush having hard bristles.

3 Again spray with forced water

4 Repeat the procedure till get cleaned.

5 Clean each louvers with cloth

Clean the water tank

1 Stop the water pump.

2 Drain out reservoir water by opening drain valve.

3 Clean entire reservoir tank with metallic wall scraper.

4 Collect all the waste including algae in a tray and dispose it in a dust bin.

5 Clean reservoir with fresh forced water.

6 Make diluted caustic soda solution and splash it along the reservoir surface.

7 Allow 20 minutes react with algae

8 Wash with forced water.

9 Allow it to dry.

In the case metallic reservoir, If require do paint.

Service water make up arrangement

1 Check water level

2 Stop water circulation pump.

3 Ensure make up water tank fill with water.

4 Open drain line valve of cooling tower tank.

5 Observe the free movement of float.

6 Open the water make up line valve

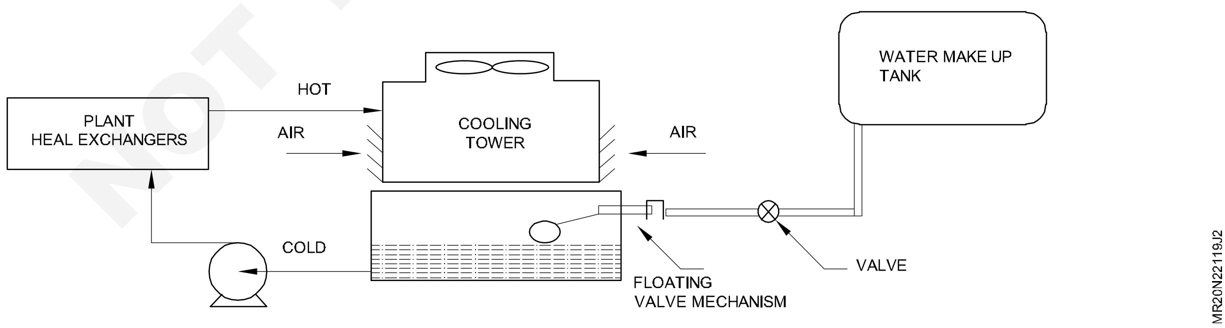
7 Observe enough water is coming through the float valve.

8 Close the drain line valve.

9 Observe the water level of tank

10 Observe whether water flow from the make up line stop when level of reservoir reached maximum. (Fig 2)

Fig 2



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TASK 3 : **Identify the parts of forced draft CT**

1 Identify the parts of forced draft C.T (Fig 1)

2 After identification, list the parts and enter into the Table 2.

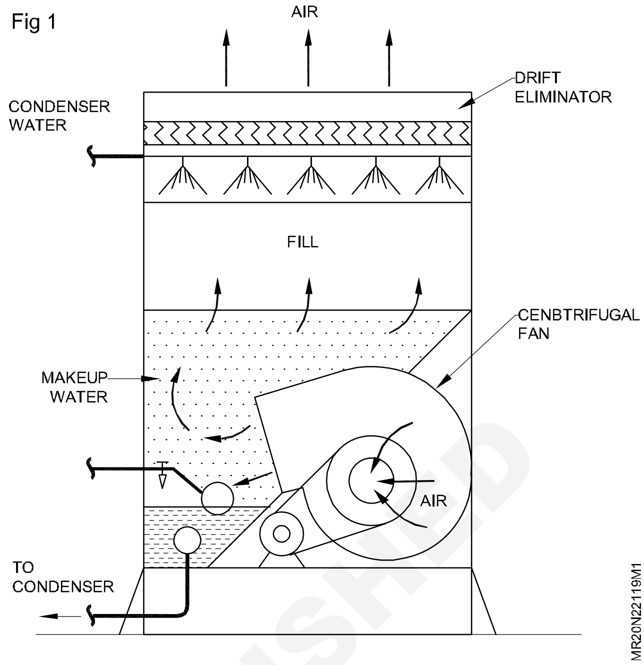
TABLE 2

Parts of forced draft cooling tower

Sl.No	Parts Identified
1	
2	
3	
4	
5	
6	
7	
8	

Trainee: **Instructor:**

Fig 1



TASK 4 : **Service forced draft cooling tower**

1 Switch off refrigeration plant.

2 Close the water lines of cooling tower.

3 Switch 'Off' the water circulating pump.

4 'Off' the cooling tower fan.

5 Dismantle fan, water pump, float valve, wire brush strainer, eliminator, spray nozzles.

Clean the spray nozzles & water tank

1 Clean the water tank by using brush, cloth and flush with water.

2 Clean the spray nozzles.

3 Clean the float valve.

4 Clean the eliminators.

5 Clean the fan, motor and lubricate.

6 Clean the water circulating pump.

7 Service the water pump, clean the impeller.

Adjust the float valve

1 Check the operation of float valve.

2 Check the water level in the water tank.

3 Adjust the float valve if necessary to maintain the water level in the water tank.

TASK 5 : **Identify the parts of induced draft cooling**

1 Identify the parts of induced draft cooling tower. (Fig 1)

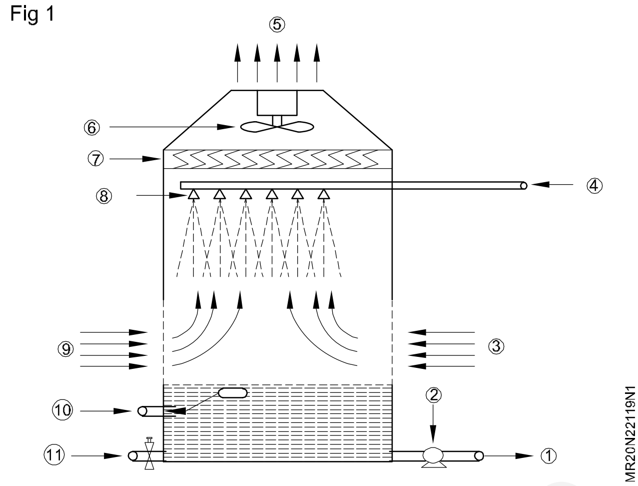
2 List the parts and entered into the Table 3.

TABLE 2

Parts of induced draft cooling

Sl.No	Parts Identified
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

Fig 1



Trainee: **Instructor:**

TASK 6 : **Service induced draft CT**

1 Dismantle the induced draft cooling tower.

2 Refer step 1 of task 4.

3 Clean the spray nozzles and water tank.

4 Refer step 2 of task 4.

5 Adjust the float valve.

6 Refer step 3 of task 4.

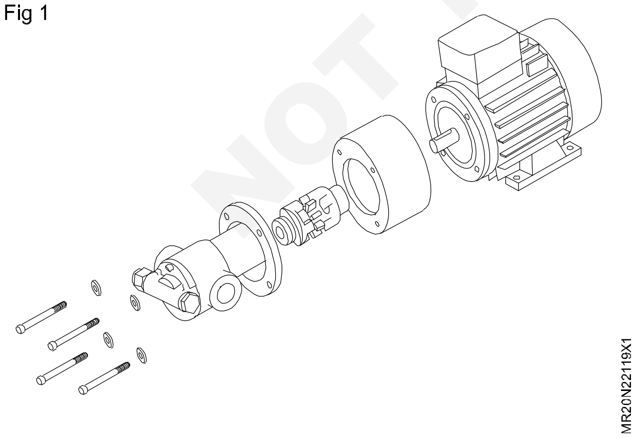
Servicing of rotary pump

Objective: At the end of this exercise you shall be able to
- **dismantle the rotary pump**
- **assembling the rotor pump.**

TASK 1 : **Dismantle a rotary pump**

- Rotor pump dismantling (Fig 1).

Fig 1



- Unscrew the 4 screws H M8 and washer M8.
- Remove the pump
- Remove the trundle
- Dismantle the coupling on the pump side : 2 screws M5 x 6.

It is useless to dismantle the coupling on the engine side. Motor pump reassembling should be carried out the opposite way.

Mechanical seal dismantle

1 At first realize the Motor pump dismantling operation (see above).

2 Remove the wedge.

3 Remove the circlip for bores.

4 Remove the circlip for shafts.

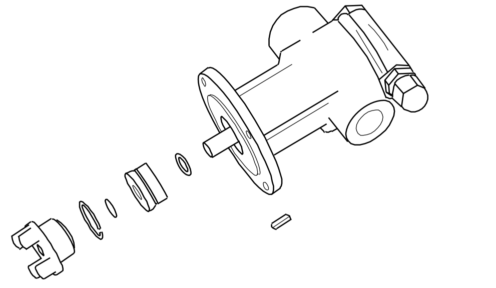
5 Remove the mechanical seal and replace it when reassembling.

6 Remove the support washer

7 Mechanical seal reassembling should be made in the opposite order.

Pump dismantling in (Fig 2)

Fig 2



1 At first realize the Mechanical seal dismantling operating (see above)

2 Unscrew the 4 screws M6 and the 2 screws.

3 Remove the cap.

While dismantling the cap, make sure you have recovered the index hand which assures the stator positioning with the cap.

1 Remove the O-ring seal.

2 Remove the 2 blades and replace it when reassembling.

3 Remove the circlip for shafts.

4 Remove the rotor and replace it.

5 Remove the stator and replace it too.

6 Pump reassembling should be made in the opposite order.

By-pass dismantling and control

By-pass calibration has already been done. While dismantling it, is important to memorize the number of fun screw rotation in order to reassemble it correctly. (Fig 3, 4)

1 Unscrew the cap nut.

2 Remove its copper joint

3 Unscrew the counter nut.

4 Remove its copper joint.

Fig 3

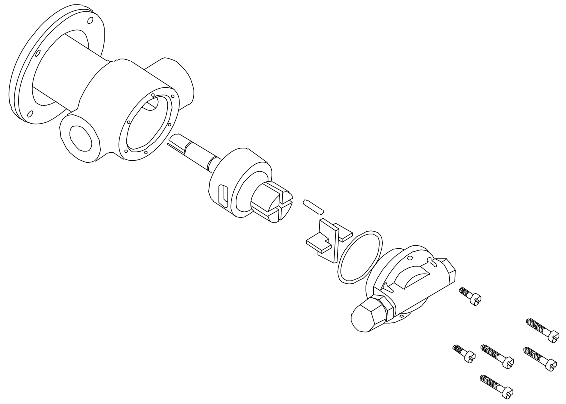
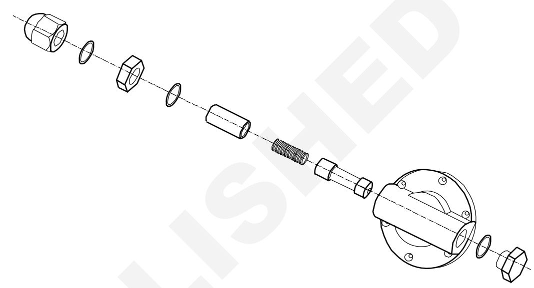


Fig 4



5 Unscrew the regulating screw and memorize the number of unscrew rotation.

6 Remove the spring.

7 Unscrew the plug.

8 Remove the copper joint

9 Remove the slide valve.

By-pass assembling

It should be done in the opposite order:

1 Check the good flap state and its seat. Screw the screw with the same number of rotation as during the dismantling.

2 This is by-pass designed as safety equipment it has to be used only in case of incident or cold start but it must not be used as a discharge regulator.

3 If you notice any flap or seat deterioration one must control the instant pressure.

— — — — — — — —

TASK 2 : **Assembling of rotor pump**

Assembling should be done in the opposite way of dismantling.

— — — — — — — —

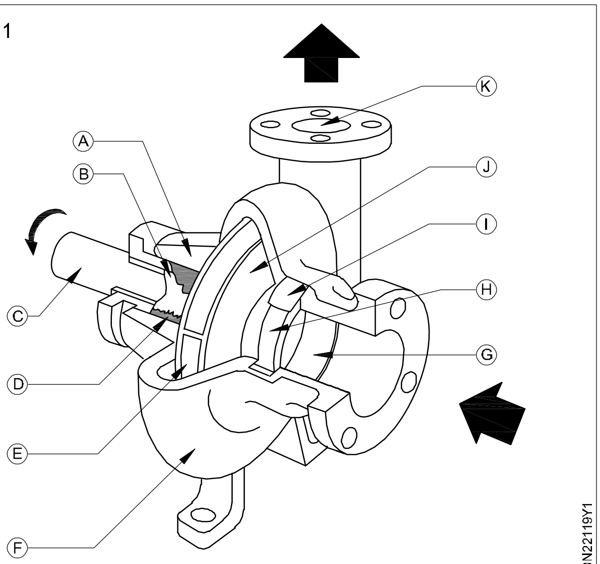
Service of centrifugal pump

Objective: At the end of this exercise you shall be able to
- **dismantle a centrifugal pump**
- **clean a centrifugal pump**
- **assemble a centrifugal pump**
- **starting a centrifugal pump.**

PROCEDURE

TASK 1 : **Dismantling of a centrifugal pump**

Fig 1



LOGIC X OR CIRCUIT

1 Before dismantling drain the Bearing Bracket of oil.

2 Unscrew filling and drain plug.

3 Drain the oil into bucket.

4 Remove the nuts which hold the bearing bracket to pump casing.

5 Pull the bearing bracket to remove the complete bearing bracket with rotor, impeller, bearings and shaft.

6 Remove the O Ring.

7 Remove the Impeller nut, washer and lock washer.

8 Pull the impeller off the rotor.

9 Pull the rotor off the shaft.

10 Pull rotor housing off the recess pump casing.

11 Remove 'O' ring.

12 Unscrew Allen screws and remove the near plate from bearing bracket.

13 Remove the shaft seal key.

14 Pull the shaft seal off the shaft.

15 Pull the shaft seal seat carefully out of the recess of the rotor hub.

16 Remove key from the shaft and remove screws.

17 Pull the bearing cover with oil sealing ring off the shaft.

18 Remove the paper gasket.

19 Pull out the shaft with bearing bracket, allowing inspection of the bearing.

— — — — — — — —

TASK 2 : **Cleaning of centrifugal pump**

1 Clean all the parts by wiping with soft waste cloth.

2 Use cleaning oil to clean the parts.

3 Clean the recess in the rotor.

4 When fitting the seat remove the protective coating if any without scratching the upper surface.

— — — — — — — —

TASK 3 : **Assembling of a Centrifugal pump**

1 Place O-ring on the collar of the rot housing and press into place in the inlet of the pump casing.

2 Fasten rear plate to the bearing bracket with allen screws.

3 Lead the shaft into the bearing bracket.

4 Mount oil sealing ring in bearing cover.

5 Place paper gasket on the bearing cover and lead cover over the shaft.

6 Fasten with Screws.

7 Mount the key in the shaft.

8 Dip the outer rubber ring of the seat into soapy water.

9 Press the seal into place with the fingers and check that all the parts are correctly embedded.

10 Lubricate the inner diameter of the slide ring rubber bellows with soapy water and push it over shaft.

11 Push the slide ring over the shaft with hand. (Note : If rubber bellows is tight, use a fitting tool and take care that the slide ring is not damaged). (If the carbon ring is not fixed, it is important to check that is fitter correctly.

12 The carbon ring can be held by a little grease.

13 Fit key for rotor is the shaft and lead the rotor over the shaft and all the way to the shoulder of the shaft.

14 Place the two guide pins is front of the rotor.

15 Place the impeller on the rotor in such a way that the two guide pins are located in the impeller looks.

16 Secure the impeller with a disc, a lock washer, and an allen screw.

17 Place the O-ring that seals between pump casing and bearing bracket on the bearing bracket where it can be held with a little silicone grease.

18 Lead the bearing bracket into place and faster with screws.

19 Mount filling and drain plug.

20 Fill the bearing bracket with oil (SAE 15W40) until half the shaft is covered.

21 When the pump has been assembled, check that the shaft rotates freely.

— — — — — — — —

TASK 4 : **Start up of a centrifugal pump**

1 Check that the shaft rotates freely without noise.

2 Check that the pump casing is filled with liquid.

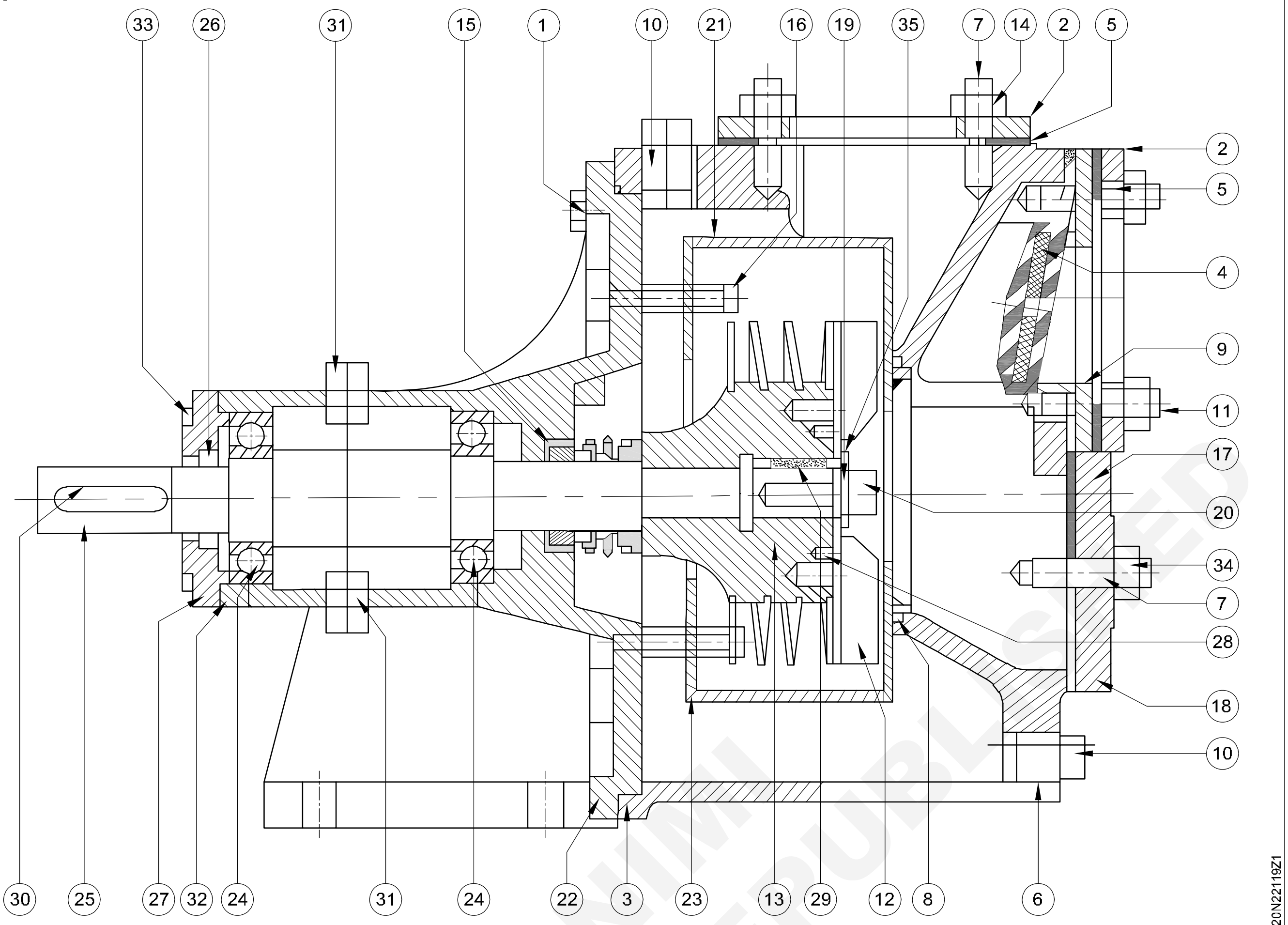
3 Switch on the pump for a moment to check the direction of rotation.

4 If the direct is correct the pump may be started.

Do not missing any hand tools into the centrifugal pump. Do not use damaged gasket.

Pos.No	Description	Qty	Item No.
01	Allen screw M8x25	6	705254
02	Counter flange	2	190534
03	O-ring	2	710952
04	Check valve	1	190543
05	Flange gasket	2	710942
06	Pump casing	1	590790
07	Stud M10x25 A4	6	700218
08	O-ring	1	710953
09	Seat for check valve	1	590800
10	Filling and drain plug ½”	2	705020
11	Stud M10x30 A4	4	700219
12	Impeller	1	190535
13	Rotor	1	190537
14	Nut M10	8	704012
15	Shaft seal	1	710949
16	Allen screw M6x40	4	704180
17	Inspection cover	1	590810
18	Gasket for inspection cover	1	190541
19	Disc M8	1	710954
20	Allen screw M8x20 A4	1	704367
21	Rotor housing	1	190538
22	Bearing bracket	1	700982
23	Rear plate	1	702387
24	Ball bearing 6206	1	590820
24A	Ball bearing 6206 IRS	1	700835
25	Shaft	1	590830
26	Oil sealing ring	1	700835
27	Bearing cover	1	590830
28	Guide pin 4x8	2	706284
29	Key for rotor	1	700012
30	Key for shaft	1	700899
32	Paper gasket	1	706287
33	Stud M6x20	4	706287
34	Nut Nyloc M10	2	703135
35	Lock washer M8	1	710948

Fig 1



33
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6
MR20N22119Z1

Dismantle and assemble water circulating pump

Objectives: At the end of this exercise you shall be able to
- **identify the parts of a centrifugal pump**
- **dismantle all parts**
- **service different type of impeller**
- **assemble compressor and test the performance.**

Requirements

Tools/Instruments

- Double end spanner 6mm to 24mm - 1 Set
- Ring spanner 6mm to 24mm - 1 Set
- Pipe wrench 300mm - 1 No.
- Hammer 1 kg. - 1 No.
- Puller with 3 leg reqd. size - 1 No.
- Mallet - 1 No.

Equipment/Machines

- Centrifugal pump horizontal split casing- single suction - 1 No.

Materials

- Kerosene - 5 ltrs.
- Brass brush flat - 150mm.
- Banian cloth - 50 cm.
- Oil in can - ½ litre.

PROCEDURE

TASK 1: **Identify the parts of a centrifugal pump**

1 Record name plate details in Table 1.

2 Identify the names of labelled parts of a centrifugal water pump from Fig 1 and record it in Table 2.

Table 1

Centrifugal water pump name plate details if any :	
Pump make	:
Model	:
Capacity in Litres/sec	:
Total meter head	:
Power consumption KW	:
Suction and delivery size	:

Table 2

Labelled No.	Name of the parts identified
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Time Taken:

Remarks

Trainee: **Instructor:**

— — — — — — — —

TASK 2: **Dismantle all parts**

1 Decouple from drive and remove coupling.

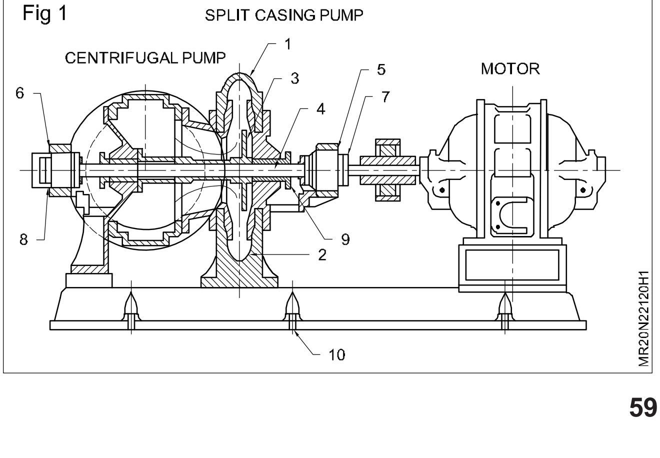
2 Open the pump split casing. (Fig 1)

3 Loosen bearing cup hold up bolts and remove bolts.

4 Remove rotating assembly.

5 Remove all parts from shaft. Punch mark the impeller side to shaft drive.

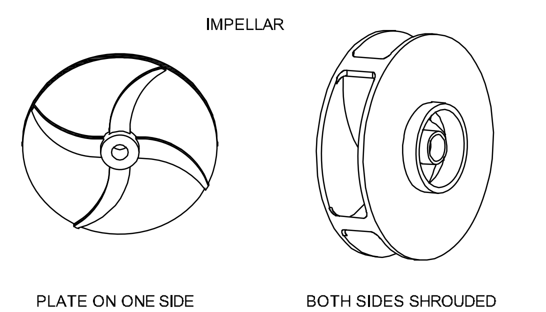
Fig 1



TASK 3: **Service different types of impeller**

1 Dismantle rotating assembly of pump
2 Remove impeller from staff punch mark the impeller side to shaft drive
3 Soak the dismantled impeller in kerosene
4 Clean impeller using brash flat brush to remove scale and rust
5 Check impeller for cracks and free inlet parts from check.

Fig 1

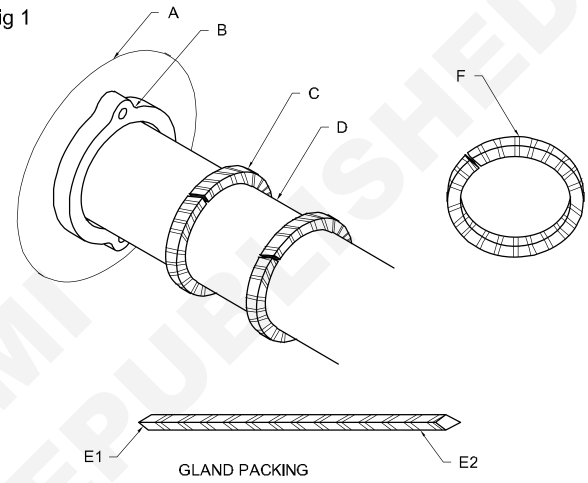


— — — — — — — —

TASK 4 : **Assemble all parts of a centrifugal pump and test performance**

1 Wipe all parts with clean banian cloth.
2 Apply thin coating of oil on all parts and assemble.
3 Fix impeller in proper direction as marked.
4 Fix all parts, use gaskets where required.
5 Apply grease in bearings and fix to shaft.
6 Fix rotating assembly to casing and place correct thickness of proper gasket to bottom casing and fix top casing.
7 Tighten all bots and pack the gland with gland rope to required size and number of ropes.
8 Rotate the shaft for freeness.
9 Put the coupling and wiring to motor.
10 Open suction and delivery values.
11 Run the pump and test the pressure and flow rate of water.

Fig 1



A - PUMP CASING
B - GLAND FLANGE
C - GLAND ROPE
D - PUMP SHAFT
E1 - GLAND ROPE ENDS CUT TO SHAPE
E2 - GLAND ROPE BEFORE FIXING IN POSITION
F - SHAPE OF THE ROPE IN ROPE

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— — — — — — — —

Familiarize with thermostatic and electronic expansion valves

Objectives: At the end of this exercise you shall be able to
- **identify the parts of a thermostatic expansion valve (TXV)**
- **identify electronic expansion valve (EEV).**

Requirements

Tools/Instruments

- Double end spanner 6mm to 24mm - 1 Set.
- Adjustable wrench 6" - 1 No.
- Tube cutter - 1 No.

Equipment

- Thermostatic expansion valve - 1 No.
- Thermostatic expansion valve with external equaliser - 1 No.
- Electronic expansion valve - 1 No.

Materials

- Banian cloth - as reqd.
- 6.00 mm flare nut - 6 Nos.
- 6.00 mm soft copper tubing - as reqd.

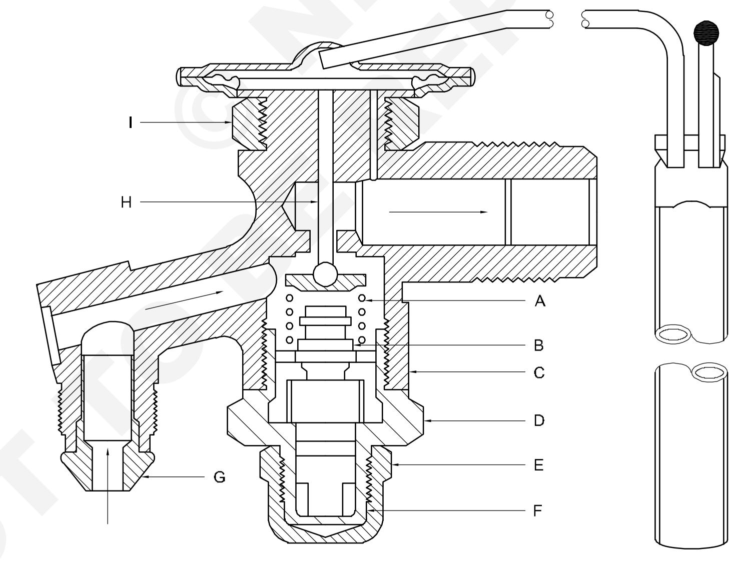
PROCEDURE

TASK 1 : **Identify the parts of a thermostatic expansion valve (Fig 1)**

1 Identify the names of labelled parts of thermostat expansion valve.

2 Record in the Table 1 of Record Sheet.

Fig 1



DIAPHRAGM TYPE THERMOSTATIC EXPANSION VALVE. NOTE A BALL IS USED AS THE VALVE, REPLACING NEEDLE. DIRECTION OF REFRIGERANT EXPANSION VALVE IS MARKED BY ARROWS.

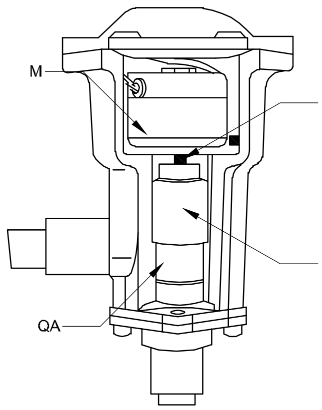
— — — — — — — —

TASK 2 : **Identify electronic expansion valve (Fig 1 & 2)**

1 Identify the names of labelled parts and functions of electronic expansion valve

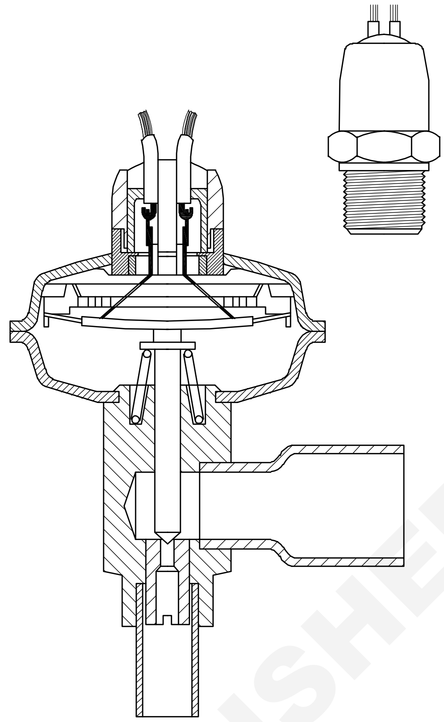
2 Record in Table 2 of Record Sheet.

Fig 1



M- MOTOR LS-LEAD SCREW PS- PISTON SLEEVE
OA- ORIFICE ASSEMBLY (WITHIN PISTON SLEEVE)

Fig 2



A THERMAL ELECTRIC EXPANSION VALVE

Record Sheet

Table 1

Thermostatic expansion valve

Labelled No	Name of parts identified
A	
B	
C	
D	
E	
F	
G	
H	
I	
J	
K	

Time taken to identify parts:

Components replaced:

Remarks

Trainee: **Instructor:**

Table 2

Electronic expansion valve

Labelled No	Names of parts identified
M	
LS	
PS	
QA	

Time taken to identify parts:

Components replaced:

Remarks

Trainee: **Instructor:**

— — — — — — — —

Identify automatic expansion valve

Objectives: At the end of this exercise you shall be able to
• identify the parts of automatic expansion valve (AEV).

Requirements

Tools/Instruments

- Screw gauge 150mm - 1 No.
- Adjustable wrench 250mm - 1 No.
- Automatic expansion valve - 1 No.
- Gauge manifold - 1 No.
- Double end spanner set - 1 No.
- Halide torch - 1 No.

Materials

- Goggles - 1 No.
- Clean cloth - as reqd.
- Charging lines - 1 No.

PROCEDURE

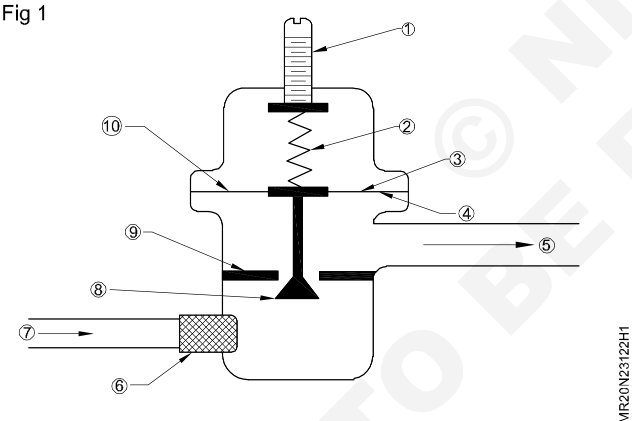
TASK 1 : **Identify the parts of automatic expansion valve**

1 Keep the AEV on the work table.

2 Identify the parts of AEV. (Fig 1)

3 Record into the tabular column.

Fig 1



Sl. No.	Parts Identified
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

— — — — — — — —

Identify extended surface forced air cooled evaporators

Objectives: At the end of this exercise you shall be able to
• identify the parts of extended surface forced air cooled evaporator.

Requirements

Tools/Instruments

- Double ended spanner - 1 No.
- Screw driver set - 1 No.
- Cutting plier 6" - 1 No.
- Line tester - 1 No.

Equipment/Machines

- Extended surface forced air cooled evaporator - 1 No.

Materials

- Cleaning cloth - 1 No.

PROCEDURE

TASK 1: **Identification and types of evaporator**

1 Identify the type of evaporator and its function record in the table 1 of record sheet.

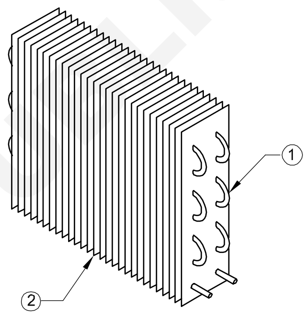
2 Observe both side of direct cooled evaporator for manufacturing details/specification if any and in record in Table -1 of the record sheet.

3 Shell types of evaporator shown in Fig 1.

TABLE 1

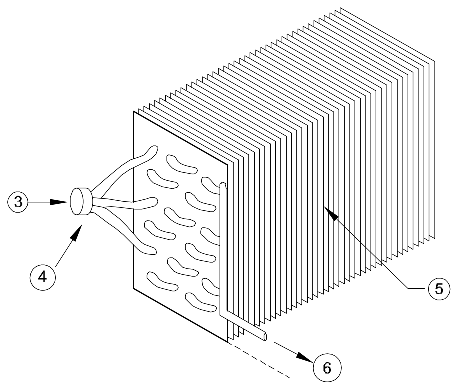
Label	Name of the parts	Specification	Function
1			
2			
3			
4			
5			
6			

Fig 1



EVAPORATOR

Fig 2



FINNED EVAPORATOR COIL

Service air cooled evaporator by blower

Objectives: At the end of this exercise you shall be able to
- **strip out the cover and clean the evaporator**
- **service and fix the unit in position**
- **check the cooling effect.**

Requirements

Tools/Instruments

- Screw driver, plastic handle 6 mm tip length 100 mm - 1 No.
- Screw driver plastic handle 10 mm tip length 200mm - 1 No.
- Pliers long nose length 200mm - 1 No.
- Chemical spray pump - 1 No.
- Fin comb - 1 No.
- Allen key fit with 'T' handle - 1 No.
- Hand air blower - 1 No.
- Trolley - 1 No.
- Service man thermometer - 1 No.
- Air velocity meter - 1 No.

Equipment/Machines

- 1 ton or 1.5 ton window air conditioner - 1 No.

Materials

- Spray chemical (vani kline)
- Nylon brush - 1 No.
- Clean cotton cloth
- Soap solution
- Bucket of water with plastic mug
- Goggles
- Mouth mask
- Hand rubber gloves

PROCEDURE

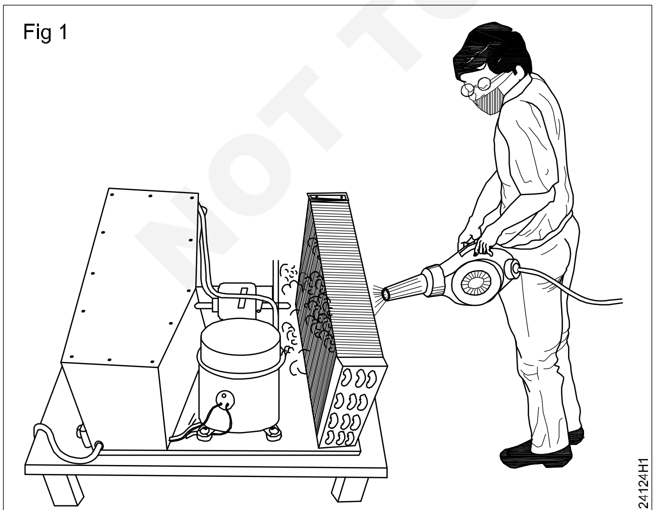
TASK 1**: Strip out the cover and clean the evaporator (Fig 1,2&3)**

1 Unscrew the sides and top of the evaporator housing remove it, cover the electrical junction box with plastic sheet.

2 Loosen the fan motor base bolts and loosen the locking allen screw by the blower use suitable allen key with 'T' handle.

3 Shake the fan motor for the blower to get free from fan motor shaft remove and keep it.

Fig 1

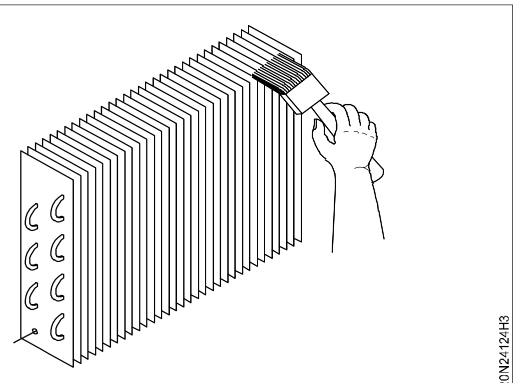


CLEANING THE FINS BY AIR-BLOWER

Fig 2

CLEANING THE FINS BY CHEMICAL SPRAY

Fig 3



COMBING FINS WITH FIN COMB

4 Wipe the evaporator coil fins both the side after brushing with nylon brush.

5 Comb and correct the fins then clean it with chemical spray condenser external cleaning, do the same procedure to evaporator fins cleaning and combing.

— — — — — — — —

TASK 2: **Service - Clean and wipe, fix the unit in position**

1 Wash the fins with soap water and clean water, blow air, clean the fins and the bed with hand air blower

2 Wipe it clean and dry the evaporator coil fins and the base of the unit.

3 Remove the plastic sheet covered to the junction box. Clean and fix the blower fan, tighten the fan motor base. check for free rotation.

4 Cover the evaporator with housing top cover by tightening the screws.

5 Move the trolley with the unit near the window frame.

6 Lift and put it with co trainees, push it in position gently.

7 Put your hand inside the evaporator air discharge plenum and rotate and check the blower and fan rotating free and smooth.

8 Place the clean filter and fix the front panel start the unit.

— — — — — — — —

TASK 3: **Check the cooling effect**

1 Check the present ambient temperature.

2 Check the room temperature.

3 Check the grill temperature.

4 Check the grill air velocity.

5 Record and find the improvement in cooling effect after service in table given below.

Table

Window AC make and capacity	**Evaporator service**	**Ambient temperature**	**Room temperature**	**Grill temperature**	**Grill air velocity**
	Before				
	After				

— — — — — — — —

Service water cooled or brine cooled chiller

Objectives: At the end of this exercise you shall be able to
- **pump down the system**
- **service the parts of brine cooled chiller**
- **leak test after assemble.**

Requirements

Tools/Instruments

- Ring spanner set - 1 Set.
- Double end spanner set - 1 Set.
- Pipe wrench - 1 No.
- Screw spanner - 1 No.
- Hammer 2 kg - 1 No.
- Chisel - 1 No.
- Scriber - 1 No.

Equipment/Machines

- Multiple brine chiller with parts - 1 No.

Materials

- Brass brush - 1 No.
- Brass scrubber - 1 No.
- 3.00 mm thick compressed asbestos fibre sheet 1 x 3 mts
- Banian cloth - as reqd.

PROCEDURE

TASK 1 : **Pump down the system (Fig 1a, b)**

1 Pump down the system as explained in Exercise 3.2.176 task 3.

2 Close Brine inlet and outlet valve.

3 Drain the brine liquid from the cooler and store in closed container.

— — — — — — — —

TASK 2 : **Service the parts of 'Brine chiller'**

1 Remove the end covers (Head A and Head B)

Take care of gaskets.

2 Inspect the tubes

3 Clean each tube internally with the tube cleaning brush which is welded to a rod.

4 Isolate the float assembly and service the float assembly and fix back after assembly.

5 Isolate the sight glass - remove the glass and clean the inside with cloth and fix back.

6 Service safety valve and fix back after service.

7 Check the pressure gauge for zero error.

8 Open shell side drain and drain oil and dirt and close drain valves.

9 Give N2 pressure through suction service valve.

10 Note the pressure and watch it.

— — — — — — — —

TASK 3 : **Leak test after assemble**

1 Check the tubes for leaks by applying soap solution.

2 If leak is found arrest the leak.

3 Connect the vacuum pump line to service valve. Start the vacuum pump and stop when reaches to 760 mm.

4 Open the gas line and break the vacuum.

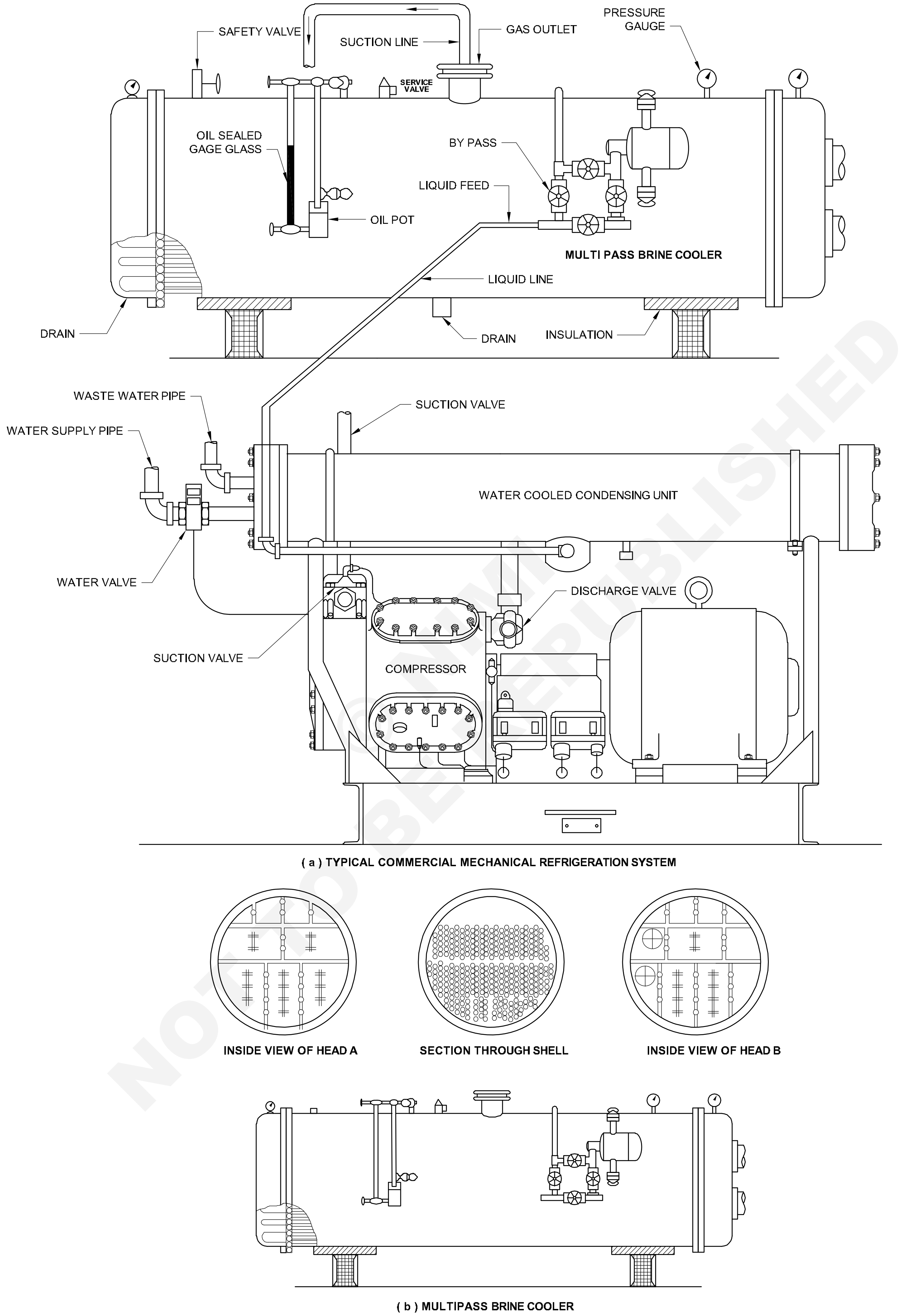
5 Cut new gasket for end covers.

6 Fix end cover. (Head A and B).

7 Open brine valve and release air lock from brine system.

8 Check brine leaks externally.

Fig 1



(a) TYPICAL COMMERCIAL MECHANICAL REFRIGERATION SYSTEM

INSIDE VIEW OF HEAD A

SECTION THROUGH SHELL

INSIDE VIEW OF HEAD B

(b) MULTIPASS BRINE COOLER

MR20N24125H1

Check defrost system and anti-freeze thermostat

Objectives: At the end of this exercise you shall be able to
- **check the water defrost system**
- **service the water defrost system**
- **check the anti-freeze thermostat and unit performance after defrost.**

Requirements

Tools/Instruments

- Double end spanner - 1 Set.
- Adjustable wrench length 250mm - 1 No.
- Screw driver 10mm tip length 200mm - 1 No.
- Scriber 150mm - 1 No.
- Mallet - 1 No.
- Series test lamp - 1 No.

Equipment/Machines

- Cold storage plant capacity 5TR with water defrost system & anti-freeze thermostat - 1 No.

Materials

- Clean cloth - as reqd.
- Teflon tape - 1 Roll.

PROCEDURE

TASK 1 : **Check the water defrost system**

1 Check whether the unit is having automatic defrost system or manual defrost.

2 Check the coating of ice on the evaporator coil is very thick and need defrost.

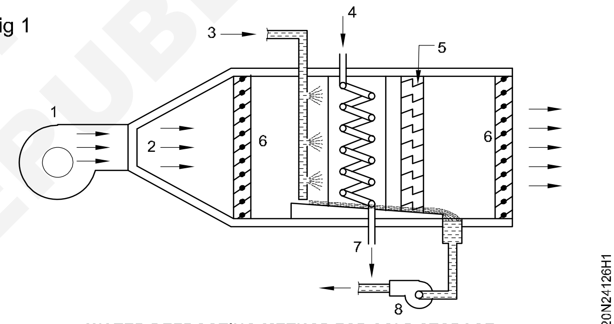
3 Record the suction and discharge pressure of the compressor, cold storage room temperature.

4 Get the clearance to stop the unit and down time limit should keep in mind.

5 If the defrost system is automatic, (by pass) disconnect the instruments contacts, stop the air circulation blower fan.

6 If louvers or dampers provided for evaporator just close it.

Fig 1



WATER DEFROSTING METHOD FOR COLD STORAGE

7 Open the defrost water circulating valve, close the drain valve then start the circulating pump.

8 Check the water is sprayed with full velocity or the nozzles are choke.

— — — — — — — —

TASK 2 : **Service the water defrost system**

1 Stop the defrost water circulating pump.

2 Open the water drain valve

3 Use the adjustable wrench and double end spanners remove the nozzles. (Fig 1)

4 Start the pump and flush out the water line for few minutes.

5 Clean the nozzles thoroughly with good water and the nozzles holes with scriber, make sure there is no blockage of sediments.

6 Clean the drain tray and the drain line for free flow.

7 Fix the nozzles firmly using Teflon tape for leak proof.

8 Now start the water circulation pump and check the water spray on the evaporator coil.

9 After clean defrost of the evaporator coil, stop the water pump, and check any ice blocks are hanging between the lines, slightly tap it with mallet, but be careful not to harm the evaporator coils.

10 Open the dampers or louvers cleanly wipe it, wait till the melted ice drains completely. (Refer related theory in 3rd Module).

— — — — — — — —

TASK 3 : **Check the anti-freeze thermostat and unit performance after defrost**

1 Disconnect the wires of anti-freeze thermostat
2 Connect them with series test lamp, and switch on. The lamp glow.
3 Unclamp and keep the thumbs bulb in the bowl.
4 Wait for five minutes the lamp will off the AFT is functioning.
5 Connect the contacts for automatic defrost instruments.
6 Start the unit with normal procedures after starting the air circulation blower fan.
7 After 2 hrs check the cold storage room temperature and compressor suction and discharge pressure, record it;
8 Compare with before and after servicing the defrost system parameter readings of the unit, confirm the performance of the cold storage unit.

Record Sheet

Table 1

Make	Capacity	Defrost Method	Manual or Automatic

Unit stopped for defrost maintenance at :

Table 2

Suction pressure	Discharge pressure	Cold storage room temperature

Unit started after defrost maintenance at :

Table 3

Suction pressure	Discharge pressure	Cold storage room temperature

Total down time of the unit :

Defrost maintenance completed date :

Remarks :

Trainee :

Instructor :

Removing oil from coil

Objectives: At the end of this exercise you shall be able to
- **check and service convention type evaporator**
- **check and service force draft evaporator.**

Requirements

Tools/Instruments

- Double end spanner set - 1 Set.
- Adjustable screw spanner length 150mm - 1 No.
- Screw driver tip 10mm length 200mm - 1 No.
- Ring spanner of set 4.7mm to 16mm - 1 Set.
- L-allen key set size 1.5 to 6.4mm - 1 Set.
- Air blower (hand set) - 1 No.
- spray pump (hand set) - 1 No.
- Dry nitrogen cylinder with accessories - 1 Set.
- Monometer
- Voltmeter
- Fin comb - 1 No.

Equipment/Machines

- Refrigeration plant 5TR capacity with convention evaporator
- Same capacity plant with force draft evaporator

Materials

- Painting brush 100mm - 1 No.
- Soft nylon brush - 1 No.
- Clean cloth
- Cleaning liquid (Venekline)
- Rubber hose with jet arrangement
- Soap solution with small container
- Thermometer (digital)

PROCEDURE

TASK 1 : **Check and service convention type evaporator**

1 Check the fins have fouling of dust or ice formation when the plant is running itself.

2 Check the fins are bent or damage

3 Check and record the suction pressure, discharge pressure, cool room temperature and evaporators refrigerant temperature (most of the models provided with dial thermometer with capillary)

4 Check the defrosting system works as per timer.

5 Pump down the system and pressure the refrigerant in liquid receiver, close inlet and outlet valves.

6 Start the defrosting and observe till, all the ice gets melted from the fins and the coils. (Remove the shroud if provided).

7 Connect the rubber hose to fresh water line.

8 Spray the water through jet on evaporator coils and fins wash thoroughly.

9 If fouling is too much, spray venekline by hand pressurized pump. Again wash with fresh water.

10 Use air blower (hand set) and clean the fins and evaporator tubes, wipe it then straighten the fins with fin comb.

11 Disconnect evaporator inlet and outlet joints, connect dry nitrogen cylinder with regulator to the the inlet, keep the outlet open.

12 Regulate the nitrogen pressure upto 10 bar(Kg/cm2) open the valve gradually and flush out the nitrogen till it gets clear from oil trace.

13 Disconnect and remove the nitrogen cylinder and connect the evaporator in line.

14 Open the liquid receiver valves and purge some refrigerant at the outlet of evaporator and tighten it.

15 Check the base bolts of the evaporator, tighten it with suitable spanners. Fix the shroud for evaporator.

— — — — — — — —

TASK 2 : **Check and service force draft evaporators.**

1 Check and record all the parameters readings, air way resistance with manometer and coil face velocity by voltmeter while the plant is running before start servicing.

2 Follow the procedure till step 15 in task 1.

3 Check and service the fan blades cleanly wipe it.

Service of liquid - suction heat exchanger used in central plant

Objectives: At the end of this exercise you shall be able to
- **check the condition of the heat exchanger**
- **flush out nitrogen through heat exchanger**
- **connect the heat exchanger and check the performance.**

Requirements

Tools/Instruments

- Nitrogen cylinder with regulator and gauge manifold - 1 Set.
- Adjustable wrench - 1 No.
- Ratchet wrench - 1 No.
- Double ended spanner set - 1 Set.
- Thermometer (-50°C to +50°C) - 1 No.

Equipment/Machines

- Refrigeration system with all the parameters in the panel board equipped with heat exchanger - 1 No.

Materials

- Charging (copper) line - 1 No.
- Clean cloth - as reqd.
- Googles - 1 Pair.

PROCEDURE

TASK 1 : **Check the condition of the heat exchanger**

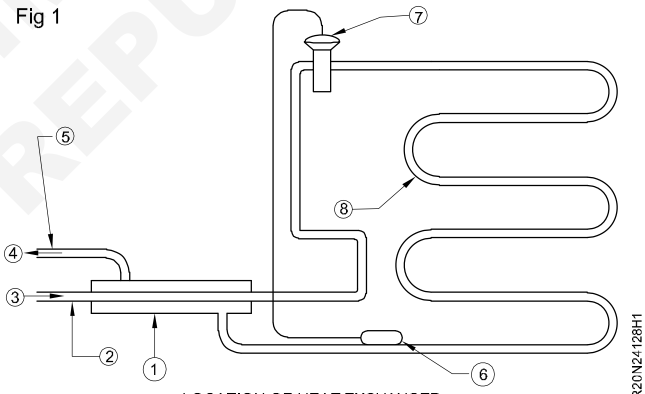
1 When the plant is running, check and record the evaporator temperature.

2 Check and record liquid lines temperature, before and after heat exchanger.

3 Find the difference in temperature, if it is minimum, confirm the heat exchanger need service.

For the location of heat exchanger. Refer Fig.1.

Fig 1



LOCATION OF HEAT EXCHANGER

— — — — — — — —

TASK 2 : **Flush out nitrogen through heat exchanger**

Flushing liquid line in heat exchanger

1 Pump down the refrigerant to liquid receiver. (Refer Exercise 3.1.176 task 3 for pump down process)

2 Wear goggles and slowly disconnect the inlet and outlet of the liquid line to heat exchanger.

3 Immediately cover the other end of the lines with dummy.

4 Connect the nitrogen cylinder with copper tube to the liquid line inlet of the heat exchanger. (Fig 2)

5 Set the nitrogen pressure by regulator, 20% higher than the operating pressures of the liquid line.

6 Open the valve and flush out the nitrogen gas through the liquid line, outlet of the heat exchanger.

7 After flushing thoroughly close the nitrogen valve and disconnect, remove the dummy then connect the liquid line to inlet and outlet.

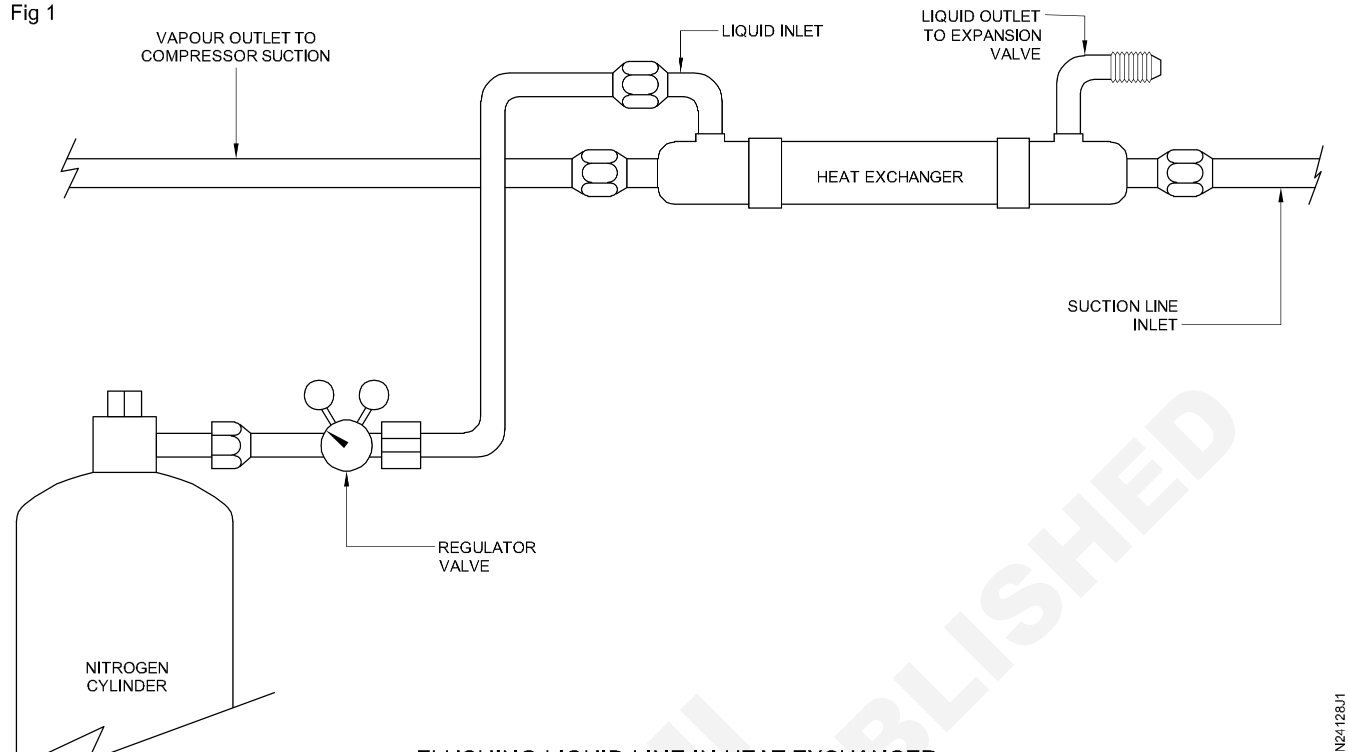
Flushing suction line in heat exchanger

1 Slowly disconnect the suction line inlet and outlet to heat exchanger.

2 Put dummy to both the ends of the suction lines. (For air not to enter).

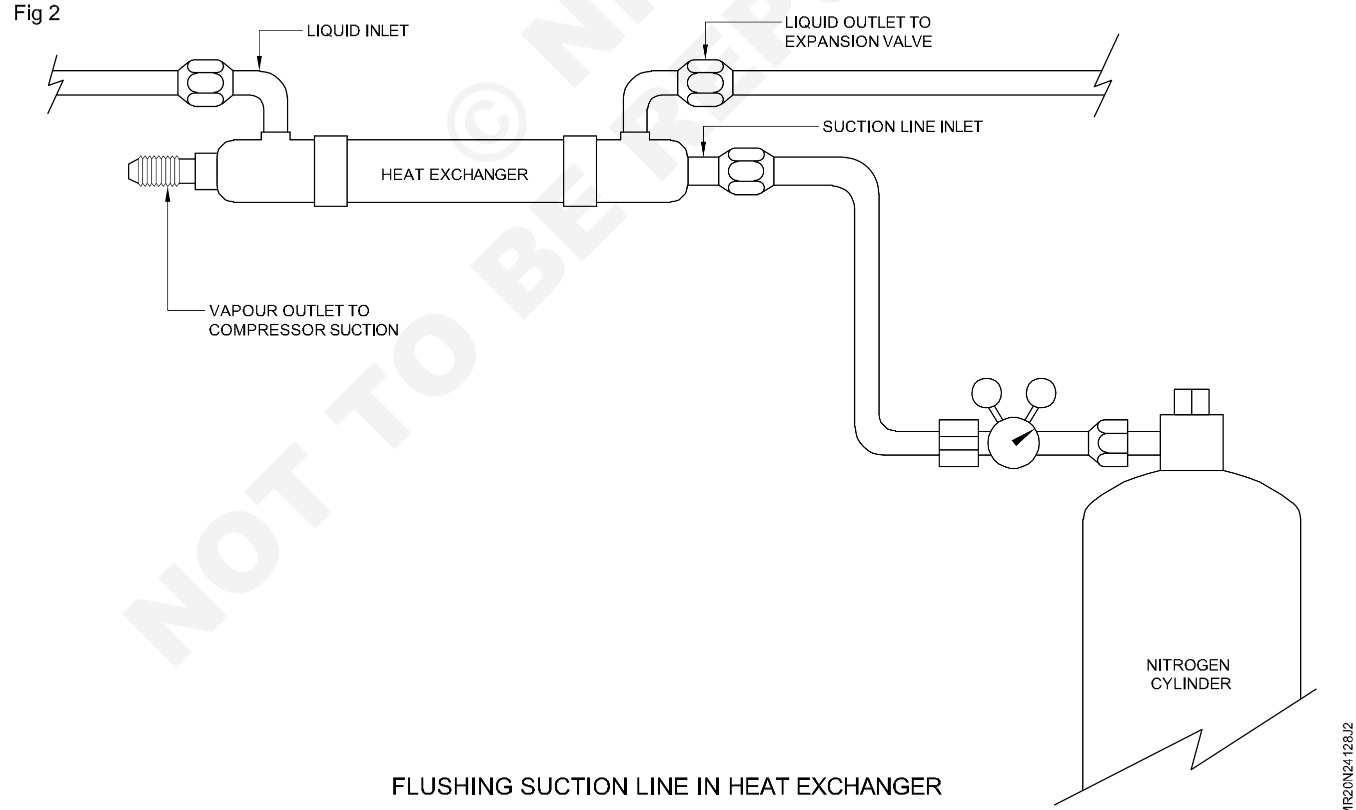
3 Connect the Nitrogen cylinder with copper tube to the suction line inlet of the heat exchanger. (Fig 3)

Fig 1



FLUSHING LIQUID LINE IN HEAT EXCHANGER

Fig 2



FLUSHING SUCTION LINE IN HEAT EXCHANGER

4 Set the Nitrogen pressure after opening the cylinder valve, by regulator, 20% higher than the operating pressure of the suction line.

5 Open the regulator valve and flush out nitrogen through the suction line, outlet of the heat exchanger.

6 After flushing out the oil coating inside the suction line, close the cylinder valve and disconnect.

7 Remove the dummy and connect the suction line to heat exchanger's inlet and outlet, wipe the outer surface of the heat exchanger with clean cloth.

— — — — — — — —

TASK 3: **Connect the heat exchanger and check the performance**

1 Normalise the service valves and king valve and let the system equalise.

2 Check the liquid line and suction lines are connected tight (leak proof) after purging the lines.

3 Normalize the safety cutout switches connections, then start the plant.

4 After an hour check and record the temperature at liquid line inlet - outlet to heat exchanger.

5 Find out the difference in temperature and record it.

6 Check the evaporator temperature, compare the previous (before service) reading.

7 Find the improvement of refrigeration effect by servicing the heat exchanger.

Record sheet

Table 1 : Reading before heat exchanger's service

Evaporator Temperature	Liquid line temperature before heat exchanger	Liquid line temperature after	Difference in temperature heat exchanger

Table 2 : Reading after heat exchanger's service

Evaporator Temperature	Liquid line temperature before heat exchanger	Liquid line temperature after heat exchanger	Difference in temperature

Evaporator temperature before service heat exchanger = ...°C

Evaporator temperature after service heat exchanger = ...°C

The improvement in refrigeration effect = ...°C

Remarks

Trainee

Instructor

Identify parts, controls electric circuit and accessories of storage type water coolers and bubble type water dispensers

Objectives: At the end of this exercise you shall be able to
- **identify mechanical, electrical components and control of storage type water cooler**
- **identify parts/controls/accessories of bubble type water dispenser.**

Requirements

Tools/Instruments

• Trainee kit	- 1 No.
• Screw driver	- 1 Set.
• Allen key (4.7mm-6mm)	- 1 Set.
• Combination plier	- 1 No.
• Nose plier	- 1 No.
• Spanners (D.E.)	- 1 Set
• Screw spanner 250mm	- 1 No.
• Tester	- 1 No.
• Pipe wrench 300mm	- 2 Nos.
• Multimeter	- 1 No.
• Clamp tester	- 1 No.
• Thermometer	- 1 No.

Equipment/Machines

• Storage type Water cooler	- 1 No.
• Bubble type water dispenser	- 1 No.

Materials

• Insulation tape	- 1 Roll.
• PVC Soln's	- as reqd.
• PVC/GI pipe (reqd. size & length)	
• Threads	- 1 bundle.
• Cotton waste	- as reqd.
• Shellac	- 1 Bottle.

PROCEDURE

TASK 1 : **Identify parts/components in storage type water cooler**

1 Switch off the water cooler if it is running.

2 Remove the water cooler service plug.

3 Unscrew the front panel screws and remove the front panel.

4 Open the water storage tank top lid.

5 Identify the components and water lines. (Fig 1)

6 Record the labelled components in table 1 of record sheet.

7 Refix the front panel with screws.

8 Close the water storage tank top lid.

Fig 1

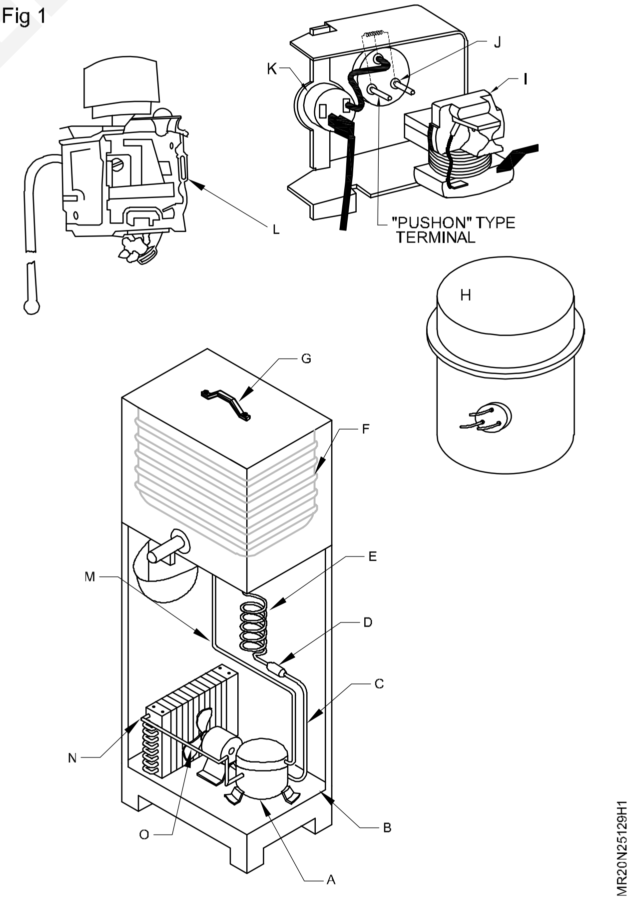


Table 1

Storage type water cooler

Label	Name of the identified component	Function
a		
b		
c		
d		
e		
f		
g		
h		
i		
j		

TASK 2: **Identify parts, control and accessories of bubble type water dispenser**

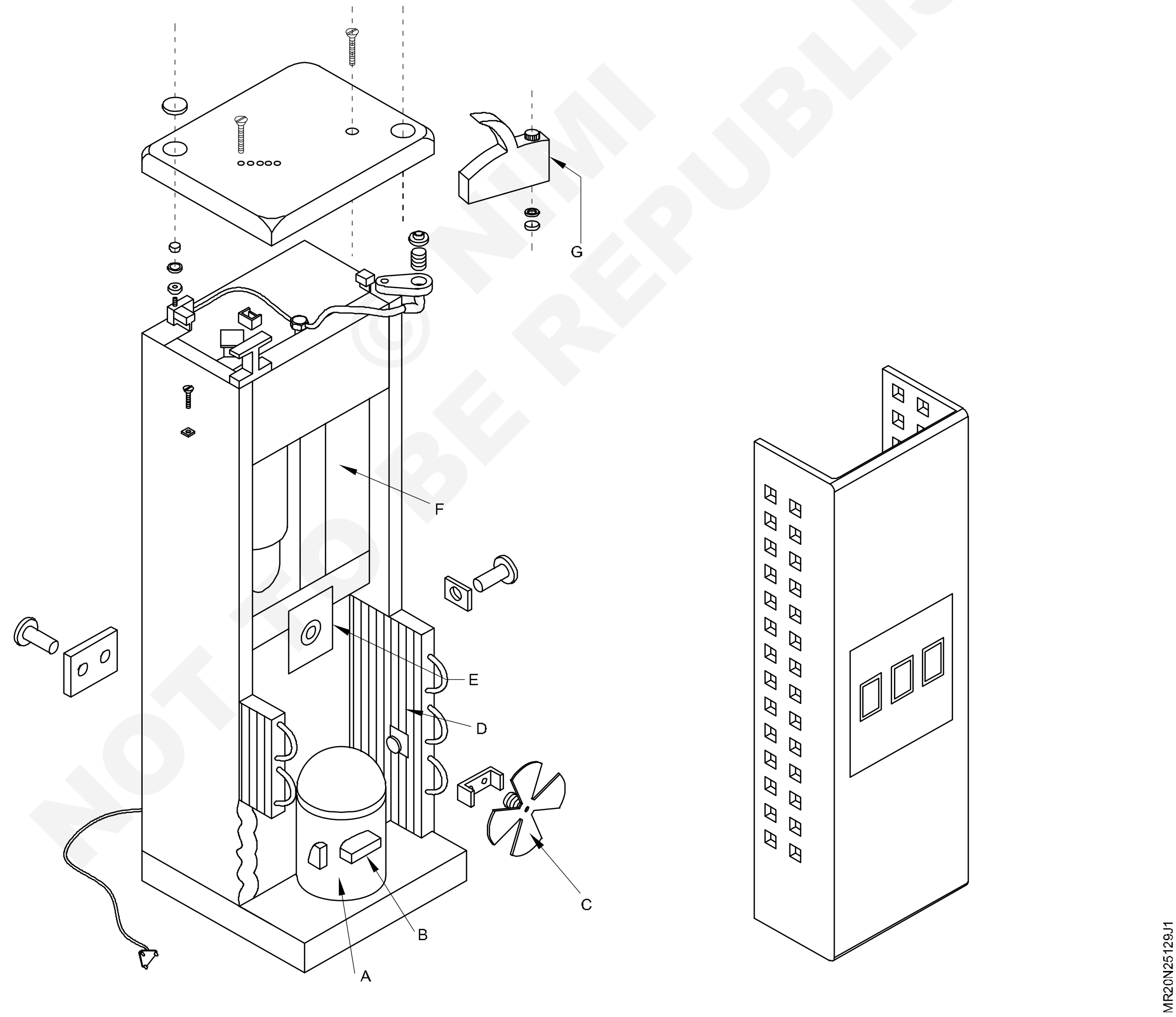
1 Switch off water cooler if it is running
2 Remove the water cooler service plug
3 Unscrew the front and side panel screws and remove panels
4 Remove water dispenser support collar and separator
5 Identify the components and water lines. (Fig 1)
6 Record the labelled components in table 2 of record sheet.
7 Refix the front panel, side panel, support collar and separator etc.

Table 2

Bubble type water dispenser

Label	Name of the identified component	Function
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		
K		
L		
M		
N		

Fig 1



21 Lengthen the coil along with marked area uniformly.

22 After the soldering is over, place the tool near the flames to get it heated.

23 Repeat the soldering operation again over the new surface.

24 Apply flux solution whenever needed.

25 Continue this operation till the complete coil is soldered.

26 Carefully bend the coil at the corners without kink or any damage.

— — — — — — — —

TASK 2 : **Take necessary steps after soldering**

1 Clean the soldered surface with brushes and dry cloth after the operation is over.

2 Clean the entire SS tank after soldering with soap water and dry cloth.

3 Leave extra copper pipe at the tank on both the ends for connection (with condensing unit)

4 Cover both ends of copper pipe with cap (to ensure outside dusts not to enter inside the coil).

5 Place all the tools/equipment at their respective place after use.

— — — — — — — —

TASK 3 : **Check water tank leakage**

1 Fill the tank with water

2 Check water leak.

— — — — — — — —

TASK 4 : **Pressure test of evaporator coil**

1 Connect suitable connector with evaporator both the ends.

2 Connect high pressure gauge at one end.

3 Apply nitrogen (Oxygen free) pressure 10 kg/cm^2 (150 psig app)

4 Test suspected points by sopa solution.

Record sheet

Size of the SS tank	**Copper tubes size & length used**	**Soldering materials used (quantity)**

Time taken to complete soldering:

Time taken for other test:

Note:

Trainee: Instructor:

— — — — — — — —

Trouble shoot of commonly faced problems like condenser fan motor failure, corrosion etc

Objectives: At the end of this exercise you shall be able to
- **identify the defects in water cooler**
- **analyse the proper cause for the defects**
- **repair/replace defective parts/components and test run.**

Requirements

Tools/Instruments

• Trainee kit	- 1 Set
• Screw driver 300mm	- 1 No.
• Combination plier	- 1 No.
• Tong tester	- 1 No.
• Hammer	- 1 No.
• Double ended spanner	- 1 Set.

Equipment/Machines

• Gas welding set with cylinder key	- 1 Set.
• Water cooler with defect condenser	- 1 No.

Materials

• Compressor oil	- 2 lts.
• Cotton waste	- as reqd.
• Soap water	- 1 Ltr.

Hints to instructor : Before commencement of this exercise, the instructor should simulate one or more faults causing the symptom of the fault given in the title of this exercise. The instructor may refer the problem tree given in corresponding lessons for some of the possible causes for fault/complaint. It is suggested that the simulated faults shall be in increasing order of difficulty as illustrated in problem trees.

If the trainee is able to trouble shoot and repair the created defect easily, simulate another fault and ask trainee to rectify the defect and so on.

PROCEDURE

1 Switch on the given unit to confirm the reported defect complaint.

2 Identify the complaint and record it in the record sheet.

3 Use the problem tree discussed in lesson for the defect/ symptom 'No cooling'.

4 Identify and record the possible causes. Dismantle the unit (or) parts if necessary.

5 Follow the logical service flow sequence (SFS) for identify the defective components (or) control and record the identified defect/fault in corresponding record sheet.

6 Ask your Instructor to check and verify the work carried out by you before proceeding further work.

7 Refer trouble shoot chart (TSC) given at the end of the exercise for the probable cause for defective/faulty component. Record the remedial measures that you propose to take for the identified defects and get it checked by your Instructor before going ahead with the repairs.

8 Repair and rectify the defect/fault with the help of suggested remedial measures given in the trouble shooting chart. Record the remedial action taken for repair and rectify the defect/ fault along with the components replaced (or) changed If any in record sheet.

9 After rectifying the fault, test the unit water cooler for its working condition in respect of its initially reported defect/fault

10 Once the repair is over, carryout the cleaning work on the unit. Assemble if it is dismantled earlier and test it again for working condition.

11 After trouble shoot and repair of the reported defect/ complaint in case any other faults exist record the cause(s) in record sheet and consult your Instructor.

Record sheet

Manufacture details of water cooler:

Reported defect/complaint:

Identified complaint/fault:

Sl.No.	Defects identified	Identified reason for the defects	Remedial measures taken	Parts/components replaced

Condition of the water cooler repairing the reported defects:

Time taken to repair for the reported defect/complaint:

Space for additional information:

Trainee | Instructor

Install gauge manifold, leak test and refrigerant charging after evacuation

Objectives: At the end of this exercise you shall be able to
- **leak-test the system and rectify defects**
- **evacuate the system**
- **charge gas to the system**
- **test run the unit.**

Requirements

Tools/Instruments

- Two stage vacuum pump - 1 No.
- Tong tester - 1 No.
- Adjustable spanner 150mm - 1 No.
- Double ended spanner - 1 Set.
- Ring spanners - 1 Set.
- Key for Nitrogen gas cylinder valve - 1 No.
- Ratchet spanner - 1 No.
- Manifold gauge - 1 Set.
- Multimeter - 1 No.
- Thermometer, Dial type 0 - 50C - 1 No.
- Combination plier - 1 No.
- Wire stripper - 1 No.

Equipment/Machines

- Water cooler at all parts - assembled stage - 1 No.
- Weighing machine - 5 Kg.
- Dry Nitrogen with regulatory valve co-ordinating Pressure relief valve - 1 No.

Materials

- Safety goggles - 1 Pair
- Hand gloves - 1 Pair
- Wiping cloth - as reqd.
- Insulation tape PVC 12mm - 1 Roll.
- Soap solution - 500ml
- Charging hose - 2 Nos.
- Dummy nuts- Brass 6mm - 6 Nos.
- T Connector - Brass - 2 Nos.

PROCEDURE

TASK 1 : **Leak test the system and rectify defects**

1 Place the unit in a more workable place.

2 Refer the name plate of unit or the manual recommending range of leak-test pressure can be carried out.

3 Make ready Dry Nitrogen cylinder of 146.2kg/cm^2 pressure with pressure regulating valve and pressure safety valve or pressure relief valve.

4 Connect one end of the lengthier (long hose) to the out let of Dry Nitrogen Cylinder safety valve (Pressure Relief valve)

5 Connect charging line of the unit to other end of hose with service shut-off valve.

6 Install a high pressure gauge to pressure regulating value.

7 Open the Dry Nitrogen slowly to build up a pressure of medium pressure from 2.11 kg/cm^2 to 7.03 kg/cm^2.

8 Read the pressure drop after on hour or more. If there is no pressure drop.

9 Raise the pressure to around 12 kg/cm^2 and if there is no decrease during 24 hours period. Test the unit for leaks using soap solution.

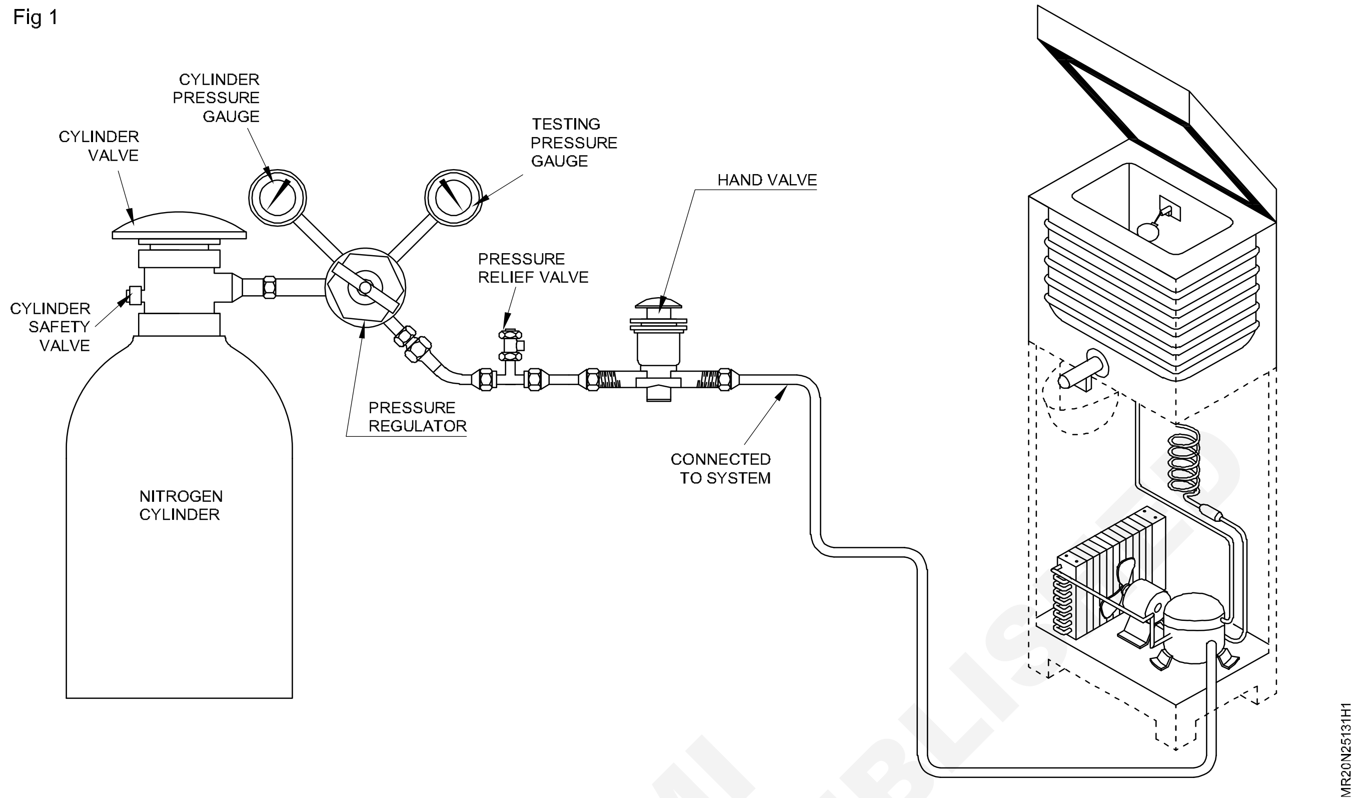
10 Keep the unit in test for 48 hours by removing hose from charge line and fixing with dummy nut. If there is leak in system.

11 Keep the unit holds pressure of 12 kg/cm^2 constantly for 48 hours the system is safe to operate.

Refer Fig.1 for details of safety valve used for leak-test.

Leak - Testing the water-cooler using Dry Nitrogen with pressure regulating & pressure relief valve.

Fig 1



TASK 2 :**Evacuate the system**

1 Remove Dummy Nut from charging line outlet.

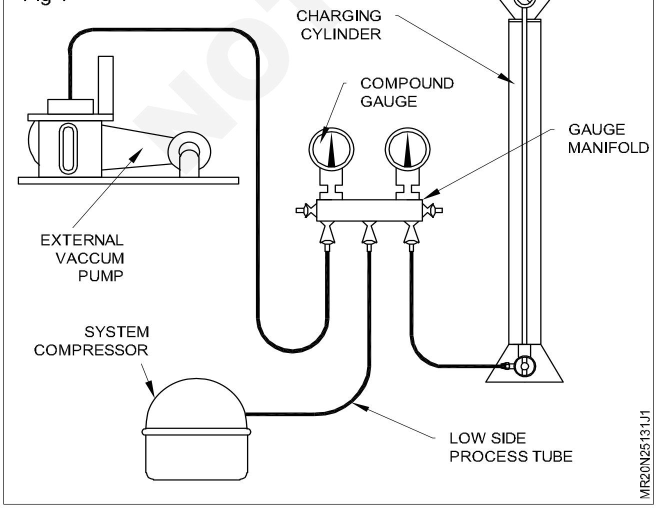
2 Open the service valve connected charging line slowly, purge out the Dry Nitrogen filled in the system.

3 Allow all the Dry Nitrogen to vent to atmosphere leaving behind around 0.21 kg/cm^2 of Dry Nitrogen pressure to equalize in the system.

4 Provide 'T' connection at charging line in order to connect to manifold gauge as shown in Fig 1

5 Fig 1 Showing charging Line connected to manifold gauge and how 2 stage vacuum and charging is done.

Fig 1



6 Connect one manifold gauge to 2 stage rotary deep vacuum pump fitted with oil ballast.

7 Close manifold Line connected to charging cylinder

8 Before starting the vacuum pump, check oil level in vacuum pump (If needed) add extra lubricating oil required.

9 Start vacuum pump, and let the vacuum pump run for 1/2 an hour to warm up vacuum pump oil in order to release water vapour submerged in vacuum pump oil through oil ballast.

10 Open the service valve at the charging line and the manifold gauge slowly/slightly (Feel the Dry Nitrogen pressure at the outlet of vacuum pump.

11 Gradually open fully the service valve connected to charging line.

12 Read the gauge pressure coming down to 50mm of Hg to 760 mm of hg.

13 Run the vacuum pump for atleast 12 to 24 hours.

14 Break vacuum twice or thrice and check if system holds vacuum.

15 Close service valve of the charging line.

16 Continue the exercise for charging of R-12.

TASK 3 : **Charge gas to the system**

1 Before commencing this exercise, prepare a test with voltmeter and ammeter fitted to mainline.

2 Connect the water cooler main heads to compressor to the prepared test board for starting the system.

3 Start charging refrigerant R-134a to the system by slowly opening the R-134a cylinder valve.

4 Loosening the hose connected to manifold purge little R-134a gas to remove unwanted gases or moisture.

5 Like-wise purge gases from hose connected to the inlet of charging line service valve.

6 Finally tighten hoses connected charging cylinder and charging line service valve.

7 Open charging line service valve and allow refrigerant to be charged to system.

8 Charge refrigerant to system slowly and steadily and note the gauge pressure.

9 Start the unit and note down the voltage, current (amperes) and ambient temperatures at the time of charging.

1 It is advisable to charge refrigerant from both high-side and low-side of the system

2 Also charge by weight (use electronic weighing machine)

3 Check the running amperes of unit to coincide with the name plate prescribed amperes.

— — — — — — — —

TASK 4 : **Test run the unit**

1 Close service valve connected to the charging line

2 Pinch the charging line and crimp it twice.

3 Leak-test the system using soap-solution

4 Seal the crimped charging end using brazing-rod

5 Load the storage tank of water cooler.

6 Run the unit for 2 to 4 hours and record the reading in record chart.

— — — — — — — —

Record sheet

1	Capacity of the water cooler	:	Lts
2	Type	:	(Instantaneous/Storage type)
3	Refrigerant used	:	
4	Test pressure of leak testing	:	Kg/cm^2 or psig
5	Level of vacuum pulled	:	microns/in.Hg.
6	Quantity of refrigerant charged	:	Kg.
7	Level of suction pressure set	:	Kg/cm^2 or psig
8	Start up and end time	:	.........hrs/min .... hrs/min
9	Total time taken for the operation	:	.... hrs/min.
10	Outdoor conditions (DBT & WBT)	:	deg.c DBT deg.C WBT

Installation, servicing maintenance and retrofit of water cooler/water dispenser

Objectives: At the end of this exercise you shall be able to
- **install water cooler / water dispenser**
- **service water cooler / water dispenser**
- **maintain water cooler / water dispenser.**

Requirements

Tools/Instruments

- Trainee kit - 1 No.
- Hammer (Medium size) - 1 No.
- Nail remover - 1 No.
- Steel ruler - 1 No.
- Screw spanners - 2 Nos.
- Pipe wrench - 2 Nos.
- Pipe thread maker - 1 No.
- Spirit level indicator - 1 No.
- Tong tester - 1 No.
- Pipe wrench - 2 Nos.
- Screw driver (150 mm & 300mm) - as reqd.
- Combination plier - 1 No.
- Wire stripper - 1 No.
- Thermometer - Digital type /Dial type /Stem type (0 to + 50°C) - 1 No.
- Stop watch - 1 No.
- Vacuum cleaner - 1 No.

Equipment/Machines

- Water cooler (new one) of required type - 1 No.
- Water cooler - storage type - 1 No.

Materials

- Wooden packs - As reqd.
- G.I. pipes (required size)
- Float assembly - 1 No.
- Wax polish - as reqd.
- Clean cloth - as reqd.
- Insulation tape - 1 roll
- Oil/grease - as reqd.
- Insulation materials (to wrap water line) - as reqd.
- Clean cloth - as reqd.
- Soap solution - 100 ml.
- Clean water - as reqd.
- Teflon tape 25 mm width - 1 Roll
- Insulation tape 12 mm width - 1 Roll
- Terminal clip-all types - 10 Nos. each
- Hose clips - 10 mm, 12 mm,16 mm dia - 5 Nos. each
- Starting relay - 1 No.
- Starting capacitor - 1 No.
- Over load protector - 1 No.
- Enamel paint (required colour) - 50 ml.
- Paint brush (12 mm width) - 1 No.
- Emery sheet - Hard - 1 sheet
- PVC insulated 1 core copper wire - 1.5 sq.mm / 2.5sq.mm - 5m each

Note: To be compatible with the compressor.

PROCEDURE

TASK 1: **Install water cooler / water dispenser**

Select location for installation

1 Select the place where machine installed will be airy.

2 Location of installation will be free from obstruction.

3 Installation sight should not have direct sun rays over the unit.

4 Ensure the location has water supply at the nearer point (5 mts.) in case of water cooler.

5 Ensure the locating sight has no obstructions from sound or materials.

6 Ensure no noise making units working nearby.

7 Installation sight should be free from pollution.

8 Ensure drain facilities nearby for draining out water from water cooler / water dispenser.

9 Ensure enough space around the water cooler for future service work.

Unpack the water cooler / water dispenser

1 Place the wooden crate (contains water cooler) in upright position (as written on the CRATE).

2 Assess the tools required to unpack it and procure the same.

3 Read out any instructions given (if any) for unpack the crate.

4 Remove the nails at the top cover (wooden) using nail remover/hammer/cradler.

5 Remove the side covers (wooden) in the same manner (using nail removers/hammer).

6 Unlock the bolts at the bottom of crate.

7 Loosen all the bolts by lifting unit from the base slightly and take out bolts/nuts.

8 Remove the bottom wooden legs by lifting out the unit. Take it out.

9 Place all the removed wooden crates in one area (for future use).

10 Check for any name plate /instruction materials pasted on the unit.

11 Clean all the outer portion of the water cooler using dry cloth.

12 Check all the parts/components/electrical parts in good condition.

13 Check for any damages/kinks anywhere in and outside the water cooler.

14 Check out cooler lids/gaskets/float assemblies (if any) and other items.

15 Note down the damages/missing of parts (if any to inform the manufacturer/supplier.

16 Remove the bottom panels (using screw driver/ spanner. Check all the inner parts/compressor/ condenser/wiring/pipe lines/controls for any damages and put back the panel/cover it.

17 Check out for scratches at the unit body and paint condition.

Position the water cooler

1 Clean the surface where the unit to be installed.

2 Ensure the surface is even (floor) (use spirit level indicator).

3 Ensure the water connections and power lines are nearer to the unit to be installed.

4 Arrange platform (concrete) to place the unit.

5 Use rubber pads at all the legs to avoid vibration.

6 Ensure no vibrations after positioned/installed.

7 Position the unit where condenser facing open area for better condensation.

8 Position the unit not facing the sun rays (as it affects the refrigeration.)

9 Place the unit where no obstructions nearby.

10 Place/position the unit nearest (possible) to the power line/water line.

11 Place the unit with sufficient clearance at all the side for free service.

Connect water line/drain line

1 Measure the distance between the unit and the water supply (shortest possible).

2 Assess the materials (bends/valves/etc.) required.

3 Procure the required materials kept ready before starts working on it (check for its quality).

4 Make line draining of the connections with necessary fittings/marks on paper for reference.

5 Provide check valve/regulating valve at any one of the end.

6 Use threads and putty at the pipe threads before connecting G.I. pipes.

7 Provide clamps on the walls wherever G.I. fittings/ pipes taken. (keep even distance.)

8 Use hose pipe at inlet point of the water cooler.

9 Provide float assembly to the storage (if the unit is not given by the manufacturer).

10 Connect G.I. pipes with necessary bends/fittings at excess water line of the storage tank,run it to drain line.

11 Provide drain line to remove waste water and spillage of water from draining surface with necessary bends/ fittings.

12 Position the drain line at slanting position to get the water flow freely.

13 Ensure all the G.I. fittings/connections are well tightened and free from leak.

14 Provide dummy plug at the storage tank and tighten it (it will be used for cleaning or servicing the tank by removing the plug).

15 Provide "P" trap at the drawn line to avoid water blockages.

16 Place rubber pad/wooden stand before water cooler (front side).

No pipe line connection needed for self contained and mini (bottle covered) water coolers. Only drain line to be provided to take out spilled water at draining area.

Operate the unit (water cooler)

1 Check the voltage at the socket (use tong tester/ multimeter.

2 Check the electrical wiring (at the installed area) for its electrical earthing. Set right it.

3 Use genuine pin top of (plug) suggested amps.

4 Ensure all the electrical connections are well connected and insulated.

5 Check all the connections for loose contacts at terminals before start up.

6 Use stabilizer to avoid fluctuations at the voltage.

7 Check all the mechanical aspects and set right (if needed) before start up.

8 Check fan blades tightened well in the condensing unit.

9 Start the unit (watch the performance).

10 Check for coldness, warmness, heat at suction, liquid and discharge lines of the unit.

11 Check the frost formation at storage tank (without water) (dry coil test).

12 Observe few cycles (cut out, cut in) of dry level at storage tank.

13 Watch out full frost formation at soldered line (outside) of storage tank.

14 Open the water line to the storage tank/fill up the tank.

15 Observe the amperage/voltage at frequent intervals and record it.

16 Record the water inlet temperature.

17 Record the temperature drop at each hour. Stirrer the water at storage tank at frequent intervals.

18 Record the voltage, amperes at constant intervals of the water cooler.

19 Watch the cut-out, cut-in performance of the cooler/ unit).

20 Watch the temperature differentials (of cut-out/cut-in).

21 Inform the customers about the technical points and how to use the water cooler.

22 Inform the client/customers the steps taken for general maintenance and how to stop the unit in case of any electrical/mechanical problem.

Record sheet

Unit Sl.No. ....
Model ....
Capacity ....
Compressor model No. ....
Fan Motor Capacity ....
Lubricated oil/grease ....
General status (unit) ....
Complaints (if any) Electrical Mechanical
Water (inlet) ....°C
Water (outlet ....°C.

Thermostat performance

(Minimum)

Sl. No.	Volts	Amps	Cut out	Cut in	Time taken	Technician signature
1						
2						

Parts (replaced) ....
Units status (after service) ....
Remarks ....
Signature (Trainee):
Signature (In charge)

TASK 2 : **Service water cooler / water dispenser**

Clean the water tank and sheet metal parts

1 Switch OFF the appliance and remove the plug from the socket, if it is kept ' ON' condition.

2 Close the inlet water (gate) valve.

3 Drain the water in the tank by keep opening / pressing the faucet.

> **The water in the tank can be taken out through the drain / remote port also, which is available at the back side.**

4 Make sure that the water in the tank is completely drained out.

5 Open the water cooler door (top side) and clean the inner surface of water tank using a wet clean cloth. (Apply few drops of soap solution on the tank surface for better effect.) Wipe off the soap solution by adding clean water and drain the mixture (soap & water).

6 Clean and dry the tank surface (inner) using a clean (cotton) dry cloth and keep open the door (10 minutes) for drying the water tank by atmospheric air.

7 Clean the exterior sheet metal surface of the appliance using a clean cloth (dry/wet). Use soap solution, if necessary.

8 Wipe off the soap and final clean the sheet metal surface.

Check the water valves

1 Make sure the water tank is clean & dry.

2 Partial open the inlet valve slowly. Check the water flows into the tank through the float valve.

3 Check the operation of float valve by lifting its lever with ball manually. Check the water flow inside the tank is stopped / reduced.

4 Make sure that there is no leak in the float ball. Hold the ball by the hand, feel like weight. If there is leak in the ball, the weight will be more due to water trapped inside.

5 Replace float ball, if necessary.

6 Check any water leak on pipe joints near the valves. If any leak is found, arrest it by tightening the valve with pipe using pipe wrenches.

> **Don't forget to close the main (water) valve at the over head water tank, when carrying out repairs in pipe lines/valves.**

7 Allow the water flow inside the tank till it reaches maximum level.

8 Ensure that there is no more water flow, after it reaches maximum limit due to float valve is closed.

Clean the Refrigeration parts & components.

1 Ensure the appliance is disconnected from electrical power supply.

2 Open the door of the condensing unit by unscrewing its screws.

3 Clean the compressor body using clean waste / cloth.

4 Clean the refrigerant (copper) pipe lines using a painting brush.

5 Clean the condenser fins surface area, by blowing the air using an air blower.

> **Wear eye goggles and hand gloves. (Wear 'mask' on the face, if necessary).**

6 Use vacuum cleaner (if necessary) for the places where air blower is not able to perform.

7 Clean the fan blade using a dry clean cloth.

Check the mechanical / electrical parts

1 Check the fan motor mounting bolts/fasteners for tightness.

2 Check the compressor mounting bolts for tightness.

3 Re-tighten the bolts/fasteners, if found loose using suitable size, double ended spanners / adjustable spanners.

4 Check the electrical wiring for any loose connections.

5 Check the unit is standing on flat-even floor level.

Replace defective parts / components

1 Check the water pipe lines for leaks, loose joints if any. Replace water tubes, hose clips (inside the water cooler) if necessary / if found defective.

2 Replace mounting bolts / nuts / washers of compressor / fan motor, if found rusted/ motor worned threads.

3 Replace fan blade, if it is defective / broken.

4 Replace the compressor spare part like starting relay / capacitor / OLP is found defective.

Check leak on refrigerant lines

1 Task some quantity of (50 ml) soap solution with clean water in a bowl.

2 Apply the soap solution on the joints (brazed) of refrigerant tubes using a painting brush.

3 Check the refrigerant tubes has any leaks.

4 Make sure there is no leak in the tubes.

Paint the sheet metal parts

1 Check the base plate (sheet metal) of the unit for any rust formation.

2 Rub the rusted places with emery sheet and clean it using a clean waste cloth.

3 Paint the surface wherever required using a brush.

4 Let the painted area to dry.

Check the performance of the unit.

1 Ensure all the parts / components are cleaned and checked.

2 Ensure defective parts are replaced.

3 Ensure that there is no leak in the refrigerant tubes.

4 Refix the condensing units door for its original position.

5 Fill water into the tank.

6 Set the thermostat to 'Low' position.

7 Connect the unit with electrical power supply.

8 Switch 'ON' the unit.

9 Observe readings and fill the values in the Tabular column which is available in the Record sheet.

Record sheet

Unit details

1 Name of the appliance	Water cooler
2 Make / Brand name	
3 Capacity	.... lts/hr.
4 Compressor make & model	
5 Water tank capacity	.... Litres
6 Type of electrical circuit	CSIR/RSIR/PSC

Service details

Make sure the following actions (put tick (Ö) mark on the spaces)

1. Cleaned : Water Tank • External surface • Condensing unit / components •

2. Checked : Water valves • Water pipe lines • Installation • Voltage • Vibration • Wiring connections • Thermostat operation • Refrigerant leak on tubes •

3. Replaced : Water valves • Water tubes • Hose clips • Fan motor / Blade • Fasteners • Compressor spares

4. Painted : Sheet metal parts •

5 Test performance:

Sl. No.	Time	Water quantity	Water temp.	Ambient temp.	Voltage	Current	Remarks
	Hrs.min	Lts.	deg.C	deg.C	Volts.	Amps.	

6 Result: Performance of the unit is satisfactory :

Trainee :

Instructor:

— — — — — — — —

TASK 3 : **Maintain water cooler / water dispenser**

Routine maintenance & service fan motor

1 Remove front cover.

2 Clean fan blade.

3 Remove fan blade & clean fan motor.

4 Clean condenser fins with brush & air blower.

5 Oil the fan motor.

6 Fix the fan blade.

Clean all part, check mounting, set thermostat

1 Clean compressor body & terminal box.

2 Check mounting/fastening of controls, motors & compressor.

3 Check leak of inlet & out let water connections faucets bubblers.

4 Test thermostat cut in and cut out temperature setting by thermometer.

Check water purifier

1 Check water filter/aqua guard/filter connection.

2 Clean/back-wash/replace filtering & purifying agent.

3 Check water leaking from inlet & outlet connection.

Check performance after service

1 Connect ammeter & check ampere.

2 Test drinking water temperature deliver through faucets.

3 Check noise/vibration.

Fig 2

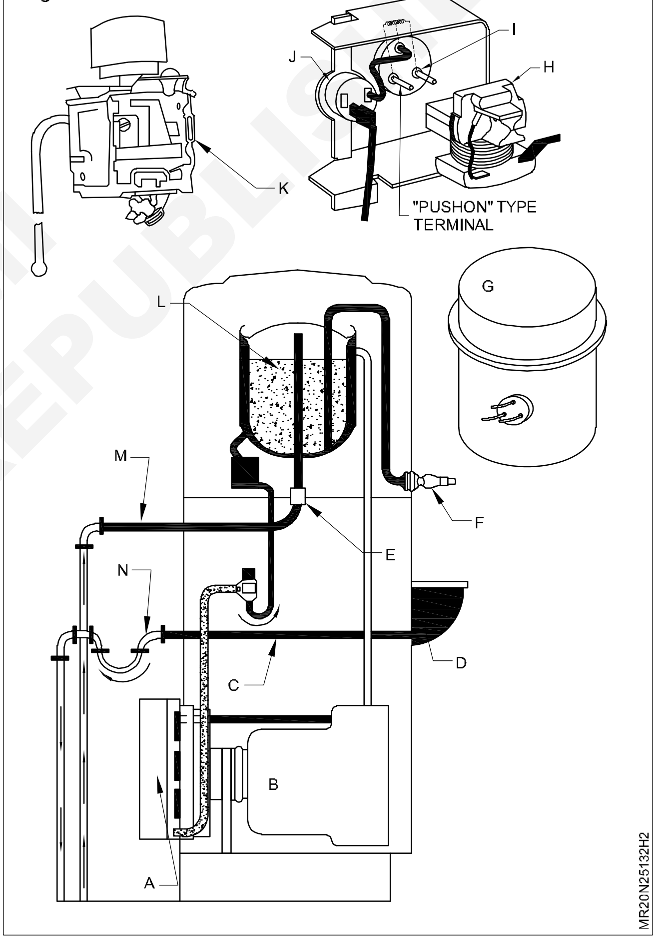


Fig 1

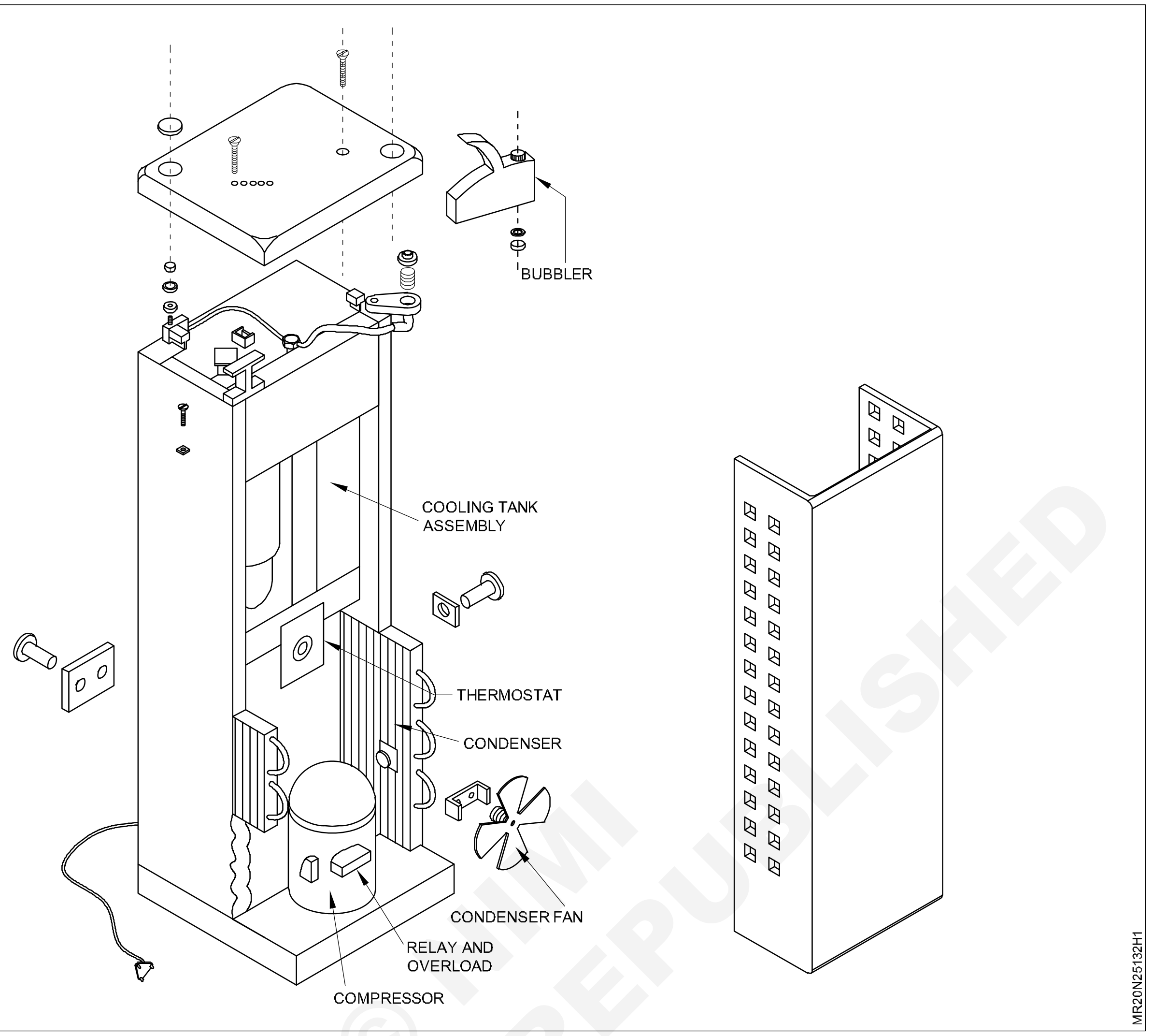


Table 1

Label	Name of the serviced component
A	
B	
C	
D	
E	
F	
G	
H	
I	
J	
K	
L	
M	
N	

— — — — — — — —

Retrofit CFC (R-12) filled water cooler with Hydrocarbon (HC)

Objectives: At the end of this exercise you shall be able to
- **inspect the fault in the CFC filled water cooler and approve for retrofitting**
- **dismantle/change the spares/components (electrical/mechanical) as required for retrofitting.**
- **recover the CFC refrigerant from the system and reprocess the same**
- **charge the Hydrocarbon refrigerant**
- **seal/pinch the process tube**
- **test performance of the system.**

PROCEDURE

TASK 1 : **Inspect the fault.**

> **It is not recommended, retrofit an appliance/ unit if it is in good working condition. so, it is required to check the unit before carryout retrofitting)**

1 Check the unit, whether it has one or the following faults.

a Refrigerant leak in the system

b Compressor failure

- Poor pumping
- Winding burnt/grounded
- Bearing struck
- Draws high current

c Compressor working, but

- Noisy
- Drawing more power

d Choke /block in the system

2 Approve the unit for retrofitting only if they need servicing/ repair due to any one of the above faults.

— — — — — — — —

TASK 2: **Recover 'Chloro Fluoro Carbon' (CFC) from the system.**

> **1 Use only CFC recovery machine.**
>
> **2 Ensure that the recovery machine is in vacuum or has no other refrigerant except 'CFC' before carryout recovery process)**

— — — — — — — —

TASK 3: **Dismantle and change the spares/components (electrical)**

> **It is best to locate the electrical spares/ components at the top of the appliance /unit. Example:Thermostat, Door switch, Wiring joints /terminals)**

1 Remove the door switch

2 Replace the thermostat by sealed type

3 Replace the lamp holder by sealed type

4 Replace the starting relay by PTC (positive temperature co-efficient) type -solid state type.

5 Replace the over load protector (OLP) by sealed type.

6 Make re-wiring according to the new location/position of the spares / components.

7 Solder the wire joints perfectly without loose connections.

8 Crimp the terminal clips with wire strands perfectly using a crimping tool

9 Put sleeves on the terminal clips

10 Make sure the wiring is correct and there is no loose connections absolutely

— — — — — — — —

TASK 4: **Dismantle and change the components (Mechanical).**

> **Hydrocarbons (HC) can be used /charged into a refrigeration system, as drop -in-replacement basis so, replacement of compressor is not essential.**

1 Replace the strainer (copper) in liquid line.

> **Don't remove the old strainer by debrazing. If the strainer is filled with 'silica gel' first cut the middle portion of strainer using a tube cutter. Remove the 'silica gel' granules and then remove the empty strainer by debrazing.**

2 Replace the capillary tube to its original (same)bore/ orifice and length

TASK 5 : **Reprocess (test leak, evacuate) the refrigeration system as per exercise 131 (a)**

> **1 Use only dry nitrogen for testing/holding pressure in the system.**
>
> **2 Never set the test pressure beyond its limits.**
>
> **3 Use soap solution with sponge/brush for finding/tracing leaks.**
>
> **4 Use only 2 stage vacuum pump for evacuating the system**

— — — — — — — —

TASK 6: **Charge Hydrocarbon (HC) refrigerant in the system.**

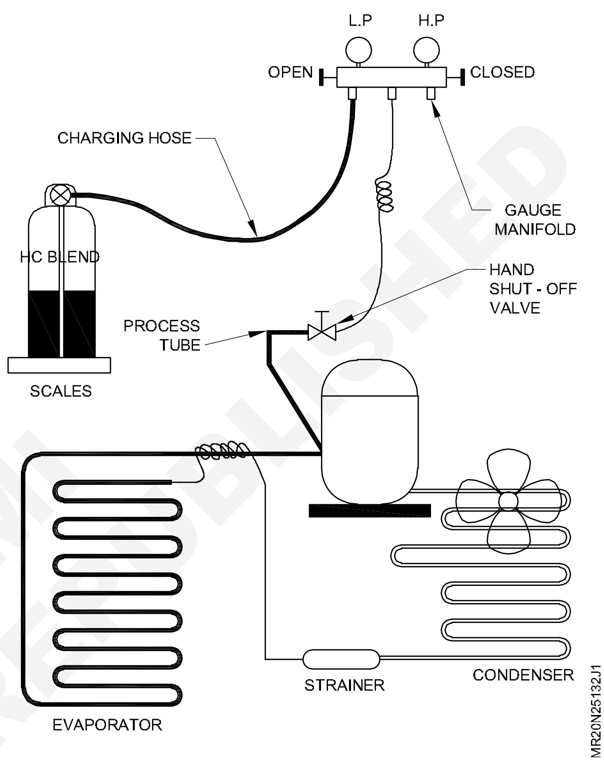
> **1 Since Hydrocarbon blend (R290) is of zeotropic type, more care to be taken during charging.**
>
> **2 Pre-determine the charge quantity (in kilo grams) of CFC, after recovering refrigerant.**
>
> **3 Make sure the charging place is free from dust and away (min.2 mts) from heat sources/ open flames.**
>
> **4 Keep the charging area ventilated.**
>
> **5 Make sure that there is no switches within 2 m of the charging area.**
>
> **6 Have a dry powder type fire extinguisher in the charging area for safety purpose.**
>
> **7 HC blend should be taken in liquid form from the cylinder, But pure HC-600a can be removed as gas.**
>
> **8 It is best and advised charging refrigerant by weight basis only.**
>
> **9 In electronic balance with accuracy of 1 g. is recommended when charging the system with less than 100 g. of HC.**
>
> **10 The required charge quantity of HC will be, 40% of CFC charge.)**

1 Connect the gauge manifold and charging cylinder with the system. (Fig 1)

2 Make sure that the refrigerant charging hoses/lines are in vacuum. If not, make arrange accordingly, since purging of lines / hoses to be avoided strictly. At the same time, at any cause air should not enter into the system.

3 Open the cylinder valve slowly, then open the charging line valve (Hand shut off valve)

Fig 1 H.C BLEND GAS CHARGING METHOD



4 Make sure the refrigerant enters in the system by watching the weighing scale.

5 Observe very carefully, the amount of refrigerant getting charge

6 Close the refrigerant cylinder valve, when the charge quantity reaching its limit before 1 to 0.5 gms.

7 Switch on the compressor and close the Hand shut off valve on the charging line

8 Disconnect the cylinder from the system.

— — — — — — — —

TASK 7 : **Seal the process tube.**

> **1 Ventilate the area before you light the brazing torch and while brazing.**
>
> **2 Strictly avoid, standing in front of the tube opening while brazing and always make sure you should not ignite any flammable materials.**

1 Pinch the process tube using pinching pliers /pinch off tool.

2 Leave the pinching plier/tool in place and use soapy water to check for leaks at the end of tube.

3 Braze the connection as normal

4 Remove the pinching pliers/tool from the process tube and test for leaks again.

5 Switch off the system.

— — — — — — — —

TASK 8: **Test performance of the system.**

1 Fix thermometer inside the evaporator tank and the tong tester on electrical phase line).

2 Switch on the compressor, observe the required parameters and record it.

Record sheet

Name of the appliance : Water cooler

Make: Capacity: ....Lts.

Refrigerant charge (CFC-12) ....g

Reason for Retrofiltting (specify the fault)........

Recovered refrigerant quantity ....g

Replaced Electrical spares:(Put **Ö** on blanks)

Thermostat ☐
Starting Relay ☐
OLP ☐

Replaced Mechanical parts / components

Compressor ☐
Strainer ☐
Capillary tube ☐

Nitrogen test pressure given ....Kg/cm^2 ....psig

Pressure holding period......................hours

Leak tested brazed joints ....

System vacuumised level ....microns

Refrigerant (HC) charged quantity...........g

Performance Test

Sl.No.	Time Hrs.Min.	Ambient Temp.°C	Voltage Volts	Current Amps.	Cabinet Temp. °C	Remarks

Trainee : Instructor :

Check and service bottle cooler and visible cooler

Objectives: At the end of this exercise you shall be able to
- **identify the parts of bottle cooler**
- **identify the parts of visible cooler**
- **service bottle cooler**
- **service visible cooler.**

Requirements

Tools/Instruments

- Tong tester / clamp meter - 1 No.
- Screw driver 5mm tip 150mm length - 1 No.
- Line tester 230V - 1 No.
- Multimeter - 1 No.
- Thermometer dial type remote bulb - 1 No.
- Screw driver 250mm length - 1 No.
- Oil can - 1 No.
- Line tester 500V heavy duty - 1 No.
- Allen key sets 1.5 mm to 4.00 mm - 1 Set.
- Screw driver set - 1 No.
- Multimeter - analog type - 1 No.
- Dial type thermometer - 1 No.
- Soldering iron
- Exchangeable copper tip 65mm - 1 No.
- Tong tester - 1 No.
- Small air blower - 1 No.

Equipment/Machines

- Vacuum cleaner - 1 No
- Direct expansion horizontal type bottle cooler - 1 No.
- Direct expansion vertical type bottle cooler (natural convection type) - 1 No.
- Vertical type bottle cooler with forced air drawn type - 1 No.
- Visible cooler - 1 No.
- Bottle cooler - 1 No.

Materials

- Goggles - 1 No.
- Hand gloves - 1 Set.
- Clean cloth ¼ m - 1 No.
- Clean water in a bucket - as reqd.
- Insulation tape - 1 No.
- Clean banian cloth 0.5 Sq.m - 1 No.
- Clean water in a bucket 10 litres - 1 No.
- Neutral detergent - 10 ml.
- Clean warm water in a container - 1 litre.
- Vinegar - 5 ml.
- Soft bristled brush - 1 No.
- Duster - 1 No.
- Condenser fin comb/fin straightener - 1 No.
- Fan motor oil (confirms to standard) - as reqd.
- Insulation tape roll - 1 No.
- Sand paper (medium grade) - 1 Sheet.
- Colour paint - 100 ml.
- Red-oxide - 1 litre.
- Cotton waste - as reqd.
- Oil - as reqd.

PROCEDURE

TASK 1 : **Identify different types of bottle coolers**

1 Observe the details of different types of bottle coolers.

2 Check which is horizontal type bottle cooler & label it.

3 Check which is vertical type bottle cooler & label it.

4 Start the bottle coolers one by one.

5 Check which has convection type evaporator and label it.

6 Check which has forced air drawn cooling cabinet and mention by label.

7 Record the labelled bottle coolers identified.

Compressor:

1 Before commencing above exercise, switch off the bottle cooler.

2 Remove the wire guard connecting condensing unit compartment.

3 Locate the compressor which is installed near fan motor.

4 Study and understand the types of compressor used in bottle cooler.

5 Identify bottle coolers employs hermetically sealed compressor.

6 Check the compressor H.P., amps, volts given in compressor, name plate.

7 Evaluate inlet and outlet of compressor by tracing suction line of the compressor.

8 Similarly locate the discharge line of compressor.

9 Now start the unit, check compressor amps and fan motor ampheres using multimeter or tong-tester.

Condenser:

10 Continue the above exercise by locating the condenser.

11 Check coil arrangement and fin arrangement in condenser.

12 Fix the condenser to bottom tray.

13 Understand by studying the fan motor and blade fitte adjacent to condenser, that the condenser is cooled by forced driven fan motor in air cooled.

Expansion device:

14 Locate and study the type of expansion device used in bottle cooler.

15 Note in direct expansion type bottle cooler capillary tube is used as expansion device.

16 Observe which type of filter drier is connected to the capillary tube.

Evaporator:

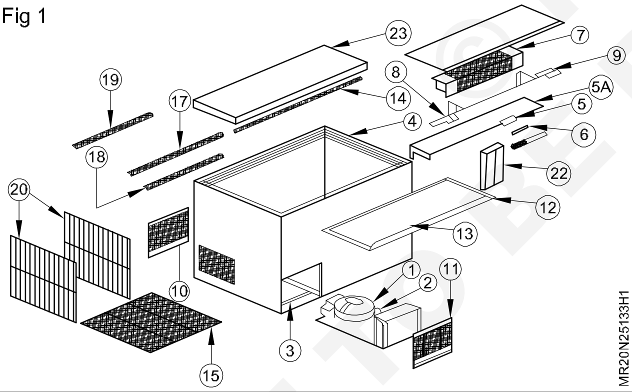
17 Locate the cooling compartment in bottle cooler.

18 Identify that there are two types of evaporator tank

19 Identify the cooling coil is wind inside storage compartment and

20 Identify the cooling coil is wind outside of the storage compartment. (Fig 1)

Fig 1



Fan Motor

1 Locate the fan motor attached to condenser in the condensing unit of the bottle cooler.

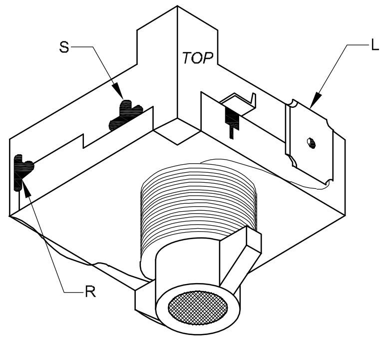
2 Switch on the bottle cooler and understand that fan motor serves to cool down the condenser coil carrying high temperature and high pressure refrigerant.

The different capacity of fan motor used with different RPM and different blade in correspondence to sizes of bottle-coolers used.

Relay

3 Identify the relay used in bottle cooler. (Fig 2)

Fig 2

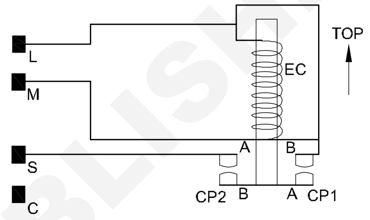


4 Switch off the bottle cooler

5 Remove the relay from the compressor.

6 Trace 'Common' or neutral wire coming from electrical circuit is first in series to OLP and again connected to 'L' marked terminal of relay. (Fig 3)

Fig 3



ELECTRICAL CIRCUIT OF DELAY IN SERIES WITH OLP

7 Keep the relay in a way as marked top of the coil facing downward side.

8 Fix the relay accordingly 'R' marked in running lead terminal of compressor and 'S' marked in starting lead terminal of compressor.

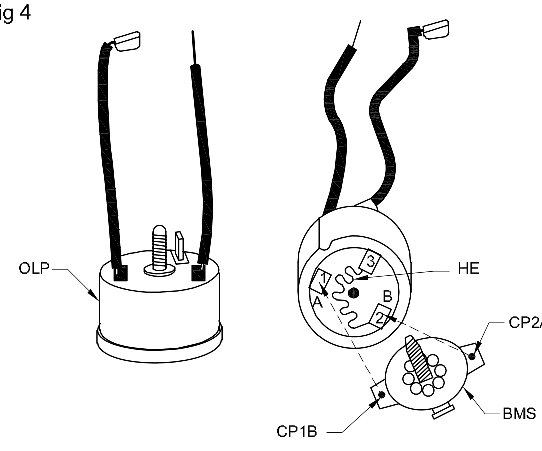
9 Start the compressor and check the function.

Overload Protector

10 Identify the overload protector in electrical circuit. (Fig 4)

11 Remove overload protector from the circuit, observe the pin arrangements and fix it back.

Fig 4



OVER LOAD PROTECTOR DISMANTLED VIEW

When the compressor draws excess current or when compressor get overheated the OLP trips and safeguard the compressor. When the high current is drawn by the compressor and when the current passing through heating element to bi-metal disc, the bi-metal disc bends and dislocates the power supply to compressor. Fig 4, thereby safeguarding compressor.

Thermostat

12 Locate the thermostat

13 Locate and study the thermostat bulb.

14 Assess the function of thermostat

15 Record the temperature in given record sheet of various capacity of bottle coolers.

By adjusting the knob in between high cool and low cool we can control the cabinet temperature as required.

Record Sheet

Table 1 : Identified bottle coolers

Sl. No.	Model No.	Name the types of labelled bottle coolers
1		
2		
3		
4		

Table 2 : Identified components & parts of bottle cooler

Components	Mechanical parts	Electrical parts

Table 3 :

Capacity of bottle cooler	Thermostat set at low cool evaporator cabinet (Temp. °C)	Thermostate set at high cool evaporator cabinet (Temp. °C)
110/120 litre		
240/280 litre		
330/260 litre		

— — — — — — — —

TASK 2 : **Identify the parts of visible cooler**

Identify the mechanical parts (Fig 1)

1 Locate the part A.

2 Locate the part B

3 Locate the part C.

4 Pull the handle to open the door.

5 Locate part D.

6 Notice the part E, which is used to hold the beverages, food products.

7 Touch the part F.

8 Locate the part G, (for air entering) of bottle cooler condensing unit.

9 Observe the parts and fill details in table 4.

Identify the components of refrigeration system (Fig 2)

Notice the rear side or front side of the cooler, remove the screws of inspection door using a screw driver.

1 Locate the component A.

2 Locate the component B.

3 Locate the component C and D.

These components can be seen from inside of the cabinet, by removing the cover of the evaporator section.

4 Locate the component E.

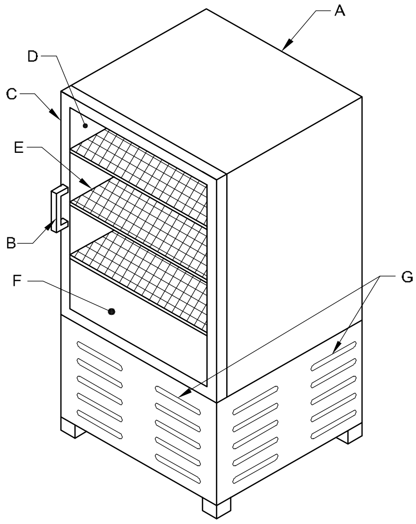
5 Observe the parts and fill details in table 4.

Identify the components of electrical circuit

1 Trace the part F.

2 Locate the part G, which will have terminal connectors, wires etc.

Fig 1



EXTERIOR VIEW OF VISIBLE COOLER

3 Close the door of the appliance.

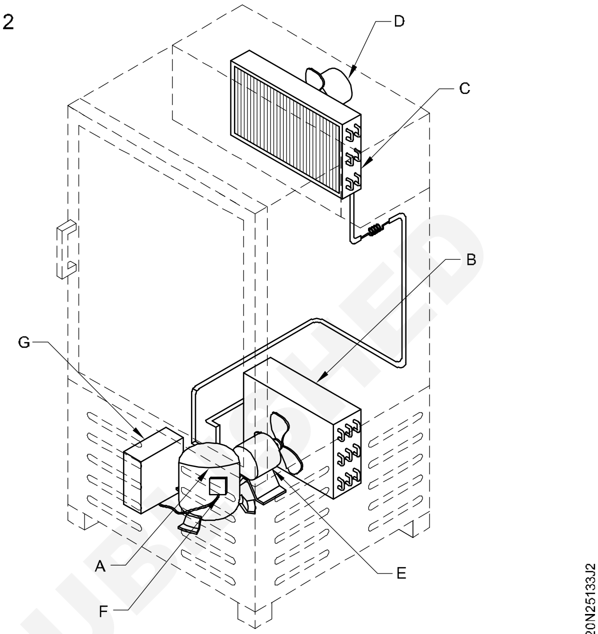
4 Observe the parts and fill details in Table 2.

Record the specifications of components

1 Record the specifications of labelled parts in table 1 and 2 which are available in record sheet.

2 Get the approval from your instructor.

Fig 2



REFRIGERATION SYSTEM & COMPONENTS VISIBLE COOLER

Record Sheet

Date :

Name of the product :

Capacity : ....lts Model : ....

Table 4 : Mechanical Parts **Components**

Label	Name of the identified part	Type/Function Specification	Label	Name of the identified part	Type/Function Specification
A			A		
B			B		
C			C		
D			D		
E			E		
F			F		

— — — — — — — —

TASK 3 : **Service external body of bottle cooler**

1 Switch 'OFF' and remove the plug top, if the unit is in 'ON' condition.

2 Shift the bottle cooler to clean workable place and remove all the food loads inside the bottle cooler.

3 Switch off the unit until all the buildup condensed frost melts and drains out.

4 Wait for some time (10 - 30 minutes) until all the water drains out

5 Clean outer body of bottle-cooler with dry cloth, before wiping with wet cloth.

6 Prepare warm water in a container.

7 Dip the banian cloth in warm water wipe all the four side body of bottle cooler. Like-wise clean the lid of bottle cooler.

8 Repeat above process several times until all the dirts are removed.

9 Using another clean cloth Dry the external body of bottle cooler.

10 Do not rub the external body in dry condition to avoid scratches.

11 Use light silicon/wax polish to clean and make glow external body.

Never use hot water for cleaning external of the unit. Do not use heavy detergent as it will diminish the paint graph detrimental to its protection Pay particular attention to the section in steel.

Service Inner body of Bottle cooler

1 Continue this exercise immediately after servicing external body and confirm the power is still switched off.

2 Dry out the water from the inside cabinet of bottle cooler using dry cloth.

3 Clean the inner body with clean cloth dipped in clean water.

4 Clean the inner body with cloth dipped in mild soap solution.

5 Add a drop of vinegar to soap water to eliminate bad odours.

6 Like wise clean with soap the inner liner of door.

7 Continue step 4 to 6 twice or thrice until all the dirt get cleaned both inner compartment and inner lines of door.

8 Rinse the inner compartment with plenty of water.

9 Check for drain pipe blockage.

10 Clean the drain pipe if necessary.

11 Dry out all the inner compartment and inner liner of door using clean, dry cloth.

Service door/lid of the bottle cooler

1 Gently open the door of the bottle cooler.

2 Inspect proper fitment of door gasket and also trace out at four corners for any damage of gasket.

3 Again by closing door, check sealing ability of door gasket, by insert a feeler gauge in between gasket and sealing area.

4 Check the alignment of door with body of bottle-cooler.

5 By removing the door, check the door hardware and find out if it is properly aligned.

6 Lubricate the latch and if necessary repairs by adjusting hinge assembly or by just changing whole hinge assembly.

7 Fit backs the door in its place and tighten the latch and hinge assembly.

8 Inspect now the door alignment and free movement of the door by opening and closing it several times.

Service the external system of bottle cooler.

1 Clean the compressor, condenser of the system using small vacuum cleaner or special vacuum cleaner using nozzle with a brush attachment.

2 If the vacuum cleaner nozzle does not reach the inner side of the condenser use a fine brush to clean the condenser and place a paper or cloth on the floor under the unit.

3 Be sure to brush to remove all the impurities such as paper or dust, dirt oil (lint) that may have deposited on the coil.

4 Check that the aluminium fins have not been damaged or bent.

5 Use condenser fin comb to straighten the damaged fins until the original condition is regained.

6 Understand combing to fins to regain original condition will optimise air flux.

7 Check that the fan is properly fixed to its frame.

8 Check the fan motor bearing for lubrication, also check the end play.

9 Lubricate fan bearing using standard lubrication and do not use refrigeration oil to lubricate fan motor.

10 Check for vibration noise in the condensing unit.

11 Check for loose baffles and ducts.

12 Check for Fan and Motor vibration.

Check, service electrical wiring and components of bottle cooler

1 Make good electrical supply at the outlet when checking and servicing hermetic electrical circuit.

2 By using voltmeter test the open circuit voltage.

3 Switch on the unit and check voltage again.

4 Record the voltage taken and understand that the open circuit voltage to be slightly higher than with the unit meter running by normally 5 volts.

5 Find out if the difference of voltage is 10 volts indicates trouble, continue to check.

6 Check the overload of compressor

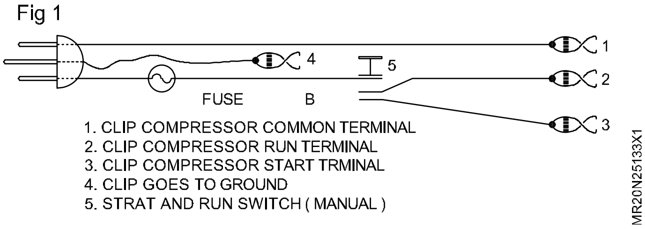
7 Check the motor winding and wiring in wall outlet

8 Find power supply is reaching compressor motor

9 Disconnect all wiring from the motor compressor

10 Then check motor compressor with manual start test as shown in Fig 1.

Fig 1



11 Connect ground clip (4) as shown in Fig 1 to body dome of compressor

12 Connect the other leads to compressor as shown in Fig 1.

13 Wear Rubber boots while carrying out above exercise

14 Press the manual switch to close run circuit, followed by start circuit.

15 Lift or release manual switch after two seconds to open start circuit.

16 Lift or release manual switch after two seconds to open start circuit

17 Check now that it the compressor run correctly.

18 Continue to locate the problem in the external circuit.

19 Like wise check the evaporator and condenser Fan motor with manual pin cord

20 For further details of servicing of Fan Motor refer (Task4) of (Servicing the external system of bottle cooler)

21 Check the starting relay and overload protector

22 Refer servicing of starting relay overload protector and thermostat in a bottle cooler.

23 Start the unit to check the performance.

a Clip compressor common terminal.

b Clip compressor run terminal.

c Clip compressor start terminal.

d Clip goes to ground.

e Start and run switch (Manual)

Electrical connections must be clean and tight. If loose or dirty, they will overheat, this overheating will discolour the connection. Refer always circuit diagram given in nameplate or manual of the unit installed for servicing.

Record Sheet

Date :

Name of the product :

Capacity : .... lts Model : .... Serial number ....

Year of manufacture :

Condition of unit on arrival before service :

Part missing

Particular	**At 35 °C**			**At 40 °C**			**Remarks**
	24 Hours run			**24 Hours run**			
Evaporator temperature	8 hrs	12 hrs	20 hrs	8 hrs	12hrs	20 hrs	
Condenser temperature							
Input voltage							
Amperes							

Name plate details

Compressor HP : Fan motor HP : Fan motor RPM :

Voltage : Watts : Capacity :

Wiring circuit details

General information

Function of unit after service

Technician remarks and signature

— — — — — — — —

TASK 4 : **Clean the sheet metal parts and components**

1 Disconnect the power supply to the unit.

2 Clean the surface of the sheet metal (external body) using a clean waste, use wet waste to remove tough dusts.

3 Open the door and remove the metallic/plastic shelves/racks from inside.

4 Wash the shelves/racks by online water (under tap water supply) and let it dry with atmospheric air.

5 Clean the inner surface of the cabinet with clean waste first, then with warm wet waste.

6 Remove the dust/dirt particles from the gap of condenser/evaporator fins using a vacuum cleaner.

> **1 The above sub-task is applicable for the units which is having forced convection/ finned type condenser and evaporator coils.**
>
> **2 When cleaning the internal cabinet, add a drop of vinegar in the warm water. Dip the clean wasted soft cloth into the warm water - vinegar solution and take out for cleaning. This method helps to remove the odour (if present) inside the cabinet.**
>
> **3 Wear hand gloves when carrying out the cleaning process.**

Check the electrical and mechanical parts/ components

1 Check the input voltage using a tong tester. Ensure that the voltage is in operating range.

> **If the unit has a voltage stabilizer, check the output voltage.**

2 Check the door gasket for air tight sealing with the cabinet.

3 Check the fan motor (s) for end play, if any

4 Check the standing level of the unit using a spirit level meter. Ensure the legs/castor wheels seated firmly on the flat floor level.

5 Check the mounting bolts/nuts/screws of fan motor/ compressor fan tightness.

> **1 The unit must be disconnected from power supply when performing the above sub-tasks.**
>
> **2 Connect the unit with power supply to perform further sub-tasks.**

6 Switch on the unit.

7 Check the cabinet light for glowing, when opening the door.

8 Check the unit for any vibration. If so, identify the fault and rectify.

9 Observe very carefully if the unit produces any objectionable noise. If so, find the reason and arrest.

10 Check the operation of the thermostat by turning its control knob to anticlockwise direction fully. Observe the compressor and fan motor(s) gets off. Wait for 3 minutes, turn the control knob to clockwise direction partially. Observe the unit (compressor and fan motor gets restarted.)

11 Switch 'Off' the unit and disconnect it from power supply.

12 Check the wiring connections for any loose connections. Make sure the terminal clips are in tight contact.

Replace defective/worn out parts/spares.

> **Before carry out the sub-tasks, it is very essential/important to confirm the defect clearly, if a part/spare needs replacement.**

1 Replace the mounting bolts/nuts/washers if found anything worn out/unusable.

2 Replace the terminal clips if found anything loose contact with wires/terminals.

3 Replace the cabinet light if it is found with fused filament.

4 Replace the drain water line if it is found with kinks or damage.

5 Replace the fibre washers in the fan motor bearings, if the motor found with the defect shaft end play.

6 Replace the fan blade(s) if it is found broken or with crack.

7 Replace the compressor spares such as relay, overload protector, capacitors, if one of these found defective/weak.

9 Replace the door gasket if it is found worn out.

Lubricate the mechanical parts.

1 Oil the fan motor(s) bearing using a oil can.

> **1 The above task is applicable for the fan motors which have oil holes in it only.**
>
> **2 Some type of fan motor will not be having oil holes which are of moulded case (sealed) type. The above task is not required for these kind of fan motors.**

Leak test the refrigerant tubes.

> **Normally this task is not essential unless the unit is found with the defects like low cooling/ no cooling etc.**

1 Take a little quantity (100 ml.) of water in a bowel. Add soap solution and mix well.

2 Apply the diluted soap solution on the brazed joints of copper tubes/refrigerant tubes by using a sponge.

3 Check any refrigerant leak is there. Rectify the leak if it is found.

Paint the sheet metal parts.

1 Inspect the units external and internal surface carefully.

2 Identify the place/part which has got rust formation or the area where the painting is pealed off.

3 Repaint the surface wherever required with suitable/ matching colour paint enamel.

> **Clean the surface (if required) using emery sheet before painting.**

4 Make the painted area dry with atmospheric air.

Recheck the performance and record the parameters

1 Ensure that the previous tasks are made successfully.

2 Ensure that sheet metal parts/spares/components are fixed/re-fixed at their own places correctly.

3 Keep the shelves/racks inside.

4 Connect the power supply to the unit.

5 Make the arrangement to record the temperatures of inside the unit.

6 Switch 'ON' the unit.

7 Ensure that the unit is restarted without any problem.

8 Watch the time & start to fill the details in the record sheet.

Record Sheet

Date :

Unit details :

Unit make : .... Model : .... Serial number ....

Capacity :

Compressor make .... Model ....

Condenser type .... Size ....

Evaporator type .... Size ....

Service details :

Make sure the following :

1 Cleaned	External surface ☐	Internal surface ☐	Condenser ☐	Evaporator ☐
2 Checked	Voltage ☐	Fan motor end play ☐		Installation ☐
	Fasteners ☐	Vibration ☐		Noise level ☐
	Drain line ☐	Thermostat operation ☐		Wiring connections ☐
3 Replaced	Fasteners ☐	Terminal clips ☐		Cabinet light/bulb ☐
	Drain water tube ☐	Fibre washer ☐		Fan blade ☐
4 Lubricated the fan motor	☐			
5 Refrigerant leak tested	☐			
6 Painted sheet metal parts	☐			
Overhauled the components	☐			
7 Unit working satisfactory	☐			

Remarks

Trainee : Instructor :

Signature

Preventive maintenance and trouble shoot visible cooler and bottle cooler

Objectives: At the end of this exercise you shall be able to
- **oil fan motor**
- **clean condenser fan**
- **check door alignment and sealing**
- **check current and power**
- **trouble shoot visible cooler and bottle cooler.**

Requirements

Tools/Instruments

- Screw driver - 1 No.
- On line tester 15A - 1 No.
- Tong tester/clamp meter - 1 No.
- Vacuum cleaner - 1 No.
- Digital thermometer - 1 No.
- Multimeter - 1 No.
- Oil can ½ lit - 1 No.
- Hammer 250g - 1 No.
- Screw driver set - 1 No.
- Combination plier - 1 No.
- Double end spanner set - 1 No.
- Tube cutter - 1 No.
- Swaging tool - 1 No.
- Flaring tool with yoke - 1 No.
- Vacuum pump - 2 stage rotary - 1 No.
- Ratchet key - 1 No.
- Vacuum gauge - 1 No.
- Manifold valve - 1 No.
- Allen key set - 1 No.

Equipment/Machines

- Visible cooler & Bottle cooler - 1 No.
- Bottle cooler with symptom "No cooling" - 1 No.

Materials

- Oil - as reqd.
- Cotton waste - as reqd.
- Cotton waste - as reqd.
- Oxy-acetylene cylinder - 1 Set.
- Wire-brush - 1 No.
- Refrigerant in a cylinder - 1 No.
- Brazing rod with flux - 1 Set.
- Capillary tube - required length
- Pencil filter - 1 No.
- New relay (suitable) - 1 No.
- Spare fan blade - 1 No.

PROCEDURE

TASK 1 : **Oil fan motor**

1 Put of the switch of unit.
2 Clean and dust using a vacuum cleaner.
3 Clean shaft of fan motor with cotton waste
4 Fill oil from port provide.
5 Clean body with dry cloth
6 Clean body of motor with oil fill cotton waste.
7 Switch on the unit check air flow and rotation.

— — — — — — — —

TASK 2 : **Clean condenser fan**

1 Unscrew condenser fan with I & key.
2 Hold fan shaft with monkey pliers.
3 Hold fan with other hand .
4 Pull by rotating blade.
5 Take out blade.
6 Clean with detergent soap solution.
7 Clean with fresh water.
8 Wipe with dry cloth.
9 Insert blade in shaft.
10 Tight the blade.
11 Run the unit check any sound or vibration.

— — — — — — — —

TASK 3 : **Check door alignment and sealing**

1 Open door and check the hinges.

2 If defect occur change the hinges or screw.

3 Check door gasket if defect occur change the door gasket.

4 Check visually any gap is there or not.

5 Run the unit and obseve any leakage is ther or not.

— — — — — — — —

TASK 4 : **Check current and power**

1 Check input line voltage

2 Run unit

3 Place clamp meter on live line.

4 Observe current drawn as per company rated or not

5 Record observation.

Record Sheet

Appliance Make .... Model....................... Sl.No.....................

Cooling capacity ....

Current rated:-_______

Current drawn._________

Hints to Instructor: Before commencing this exercise the instructor should simulate one or more faults causing the symptoms of the fault given in this exercise title. The Instructor may refer the problem tree given in corresponding lesson for some of the possible causes for the faults/complaint. It is therefore suggested that the simulated faults shall be in an increasing order of difficulty as illustrated in problem tree. If the trainee can able to trouble shoot and repair the simulated defects easily and early, simulate another defects/fault and ask the trainee to rectify and so on.

— — — — — — — —

TASK 4 : **Trouble shoot bottle cooler / visible cooler**

I A bottle cooler / visible cooler with fault created "No Cooling" will be given in this exercise. Follow the procedure given below to identify the defects " No cooling" and repair/ rectify in a given bottle cooler.

1 Switch on the given bottle-cooler / visible cooler to confirm reported faults/complaint record the identified complaint in a record sheet.

2 Using the problem tree as better discussed in the exercise for the defect "No Cooling" Identify and record other possible causes Dismantle the bottle cooler if found necessary.

3 Follow service flow sequence (SFS) to identify the' No Cooling' as and when you identify the defects , record the identified faults in corresponding Record Sheet.

4 Get the Recorded faults verified by your Instructor before proceeding further.

5 Refer trouble shooting chart (TSC) for the probable causes of the defects given in the end of this exercise.

Record the remedial measure that you propose to take for the identified defects and get checked by your Instructor before going ahead with repairs.

6 Get the given bottle cooler / visible cooler with above faults, get it repaired and rectify with the help of remedial measures given in trouble shoot chart. Record your remedial action taken by you to repair/ rectify faults along with any components replaced in Record Sheet.

7 As soon as the faults of bottle coolers/ visible cooler rectified. Get it checked and test working condition of bottle cooler in respect of its initially reported fault.

8 Once fault identified, repaired, carry out the general servicing of Bottle cooler / visible cooler. Assemble and test the bottle cooler for its working condition.

9 After repairs for the reported faults, In case any other fault exist, record the fault in record sheet and consult your Instructor.

Service Flow Sequence for "No Cooling"

1 Check for thermostat setting

- Thermostat set to warmer position/faulty thermostat
- Thermostat electrical contacts open

2 Check for shortage refrigerant

- Leak in the system
- Poor brazing
- Vibration / Improper installation

3 Check for system choking

- Capillary block
- Refrigerant oil waxy/contaminated oil

4 Check for loose wiring

- Loose connections
- Poor workmanship

5 Check for defective compressor

- Mechanical parts damaged
- Winding burnt
- Spares failure

6 Check income voltage

- Problem in main / circuit overloaded
- Install proper transformer

Troubleshooting Chart

Probable defects	Causes/Reason	Remedial measure
Improper/wrong thermostat setting	Thermostat set to warmer position	Set thermostat to medium position
Shortage of refrigerant	Thermostat electrical contacts open	Rectify and repair the defects
	Leak in the system through 'Improper brazing'	Repair, evacuate and recharge the system
Choke in system	Capillary blocked by contamination	Replace capillary, make deep evacuation and recharge the system
Defective compressor	Winding burnt/mechanical parts damaged spares	Rewind, change spares/replace compressor
Low Incoming voltage	Problem in mains/circuit overloaded	Repair main/install separate lines with a breaker

II A bottle cooler / visible cooler with a fault created "poor cooling" will be given in this exercise. Follow the procedure given below to identify the defects 'poor cooling' and repair / rectify the given bottle - cooler.

1 Switch on the given bottle cooler to confirm the reported fault / complaint. Record the identified complaint in Record Sheet.

2 Using the problem tree as better discussed in exercise for the defects ' poor cooling' identify and record the possible causes. Dismantle the bottle cooler if found necessary.

3 Follow (SFS) service flow sequence to identify the fault ' poor cooling' As and when you identify the defects, record the identified faults in corresponding record sheet.

4 Get the recorded faults verified by your Instructor before proceeding further.

5 Refer trouble shooting chart (TSC) for the probable causes of the defects given in the end of this exercise. Record the remedial measure you propose to take for identified defects and get it checked by your instructor before going ahead with repair.

6 Get the bottle cooler with above fault, get it repaired and rectify with the help of remedial measures given in trouble shoot chart. Record your remedial action taken by you to repair/rectify faults along with any components replaced in record sheet.

7 As soon as the faults of bottle cooler rectified, get checked and test its working condition of bottle cooler in respect of its initially reported / fault.

8 Once fault identified, repaired, carry out the general servicing of the bottle cooler. Assemble and test bottle cooler for its working condition.

9 After repair for the reported faults, In case any other fault exist, Record the fault in record sheet and consult your Instructor.

Service Flow Sequence for 'Poor cooling'

1 Check for compressor pumping

- Compressor not pumping adequately
- Low discharge pressure
- High suction pressure

2 Check for incorrect refrigerant charge

- Under charge of refrigerant
- Over charge of refrigerant

3 Check for partial restriction in evaporator

- Accumulation of foreign matter
- Accumulation of tiny moisture

4 Check for choke in system filter or capillary

- Strainer filter clogged
- Capillary block

5 Check for insufficient air movement over condenser

- Check fan motor blade
- Check for motor capacitor
- Check fan motor RPM
- High ambient temperature around condenser

Trouble shooting chart for 'Poor cooling'

Probable defects	Causes/Reasons	Remedial measures
Defective compressor	Compressor not pumping High side pressure low Low side pressure higher	Repair compressor / change sealed system
Incorrect refrigerant charge	Under charge of refrigerant Overcharge of refrigerant	Charge required refrigerant by weight Purge excess refrigerant
Partial restriction matter	Accumulation of foreign pressure test,	Recover refrigerant, clean the system,
moisture	Accumulation of tiny system by weight	Evacuate (Deep vacuum) and charge the
Choke in capillary/ filter strainer	Strainer filter clogged Wax blocked in capillary of refrigerant oil	Change filter De-wax capillary or change capillary
Blocked condenser Insufficient air movement over condenser	Damaged fan motor blade Defective fan motor capacitor Low fan motor RPM High ambient temperature around condenser	Change Fan blade Replace capacitor Rewind / replace Fan Motor Move the unit to more colder and airy place

III A bottle cooler with a fault created 'unit trips by high current' will be given in this exercise. Follow the procedure given below to identify the defects ' unit trips high current' and repair / rectify the given bottle-cooler.

1 Switch on the given bottle cooler to confirm the reported fault / complaint. Record the identified complaint in Record Sheet.

2 Using the problem tree as better discussed in the lesson for the defect "Unit trips by high current", identify and record the possible causes. Dismantle the bottle cooler if necessary.

3 Follow (SFS) service flow sequence to identify the fault" Unit trips high current". As and when you identify the defects, record the identified faults in corresponding record sheet.

4 Get the recorded faults verified by your instructor before proceeding further.

5 Refer trouble shooting chart (TSC) for the probable causes of the defects given in the end of this exercise. Record the remedial measure you propose to take for identified defects and get it checked by your instructor before going ahead with repairs.

6 Get the bottle cooler checked with above fault, get it repaired and rectify with the help of remedial measures given in TSC. Record your remedial action taken by you to repair/rectify the faults along with any components replaced in record sheet.

7 As soon as the faults of bottle cooler rectified get checked and test its working condition of bottle cooler in respect of its initially reported fault.

8 Once fault identified, repaired, carryout the general servicing of the bottle cooler. Assemble and test bottle cooler for its working condition.

9 After repair for the reported faults, In case any other fault exist, record the fault in record sheet and consult your Instructor.

Service flow sequence for Unit trips by high current

1 Check for input voltage
   - Wide voltage fluctuation
   - Faulty wiring / problems in main
   - Install separate transformer

2 Check for defective relay coil
   - Electrical contacts open
   - Loose mounting / compressor terminal loose contact
   - Relay make mismatch compressor/under capacity relay

3 Check for defective overload protector
   - Burned OLP / Broken OLP

4 Check for starting capacitor defects
   - Weak capacitor
   - Bulged capacitor

5 Check for defective compressor
   - Mechanical parts damaged
   - Starter motor mounting spring broken
   - Lubrication of compressor
   - Weak starting winding

6 Check for liquid refrigerant flood back
   - Defective thermostat/Thermostat not making cut out

7 Check for poor condensation

- Condenser blocked fins
- Condenser fan slipped from shaft
- Condenser for motor weak
- High ambient temperature

8 Check for overcharge of refrigerant

- Excess refrigerant charge

9 Check for load on cooling compartment

- Evaporator overloaded

Trouble shooting chart for 'Unit trips by high current'

Probable defects	Causes/Reasons	Remedial measures
Low incoming voltage	Faulty wiring Problem in main Wide voltage fluctuation	Repair and rectify wiring Install separate line with breaker Install transformer /stabilizer
Defective relay coil	Electrical contacts open Loose mounting of relay Compressor terminal loose contact	Rectify defects or replace Mount relay properly Repair compressor terminal or replace relay
Defective overload	Burned/broken OLP	Change OLP
Defective starting capacitor	Weak capacitor Bulged capacitor	Change capacitor
Defective compressor	Mechanical parts damaged Starter, motor mounting spring broken/shortage of oil Weak starting winding	Repair & replace necessary parts Repair or replace compressor charge required refrigerant oil Re-wind compressor motor.
Liquid refrigerant flood back	Thermostat not making cutout	Change thermostat
Poor condensation	Condenser fins blocked Fan blade slipped from shaft Fan motor weak High ambient temperature	Clean condenser Fix properly condenser fan blade Change Fan motor Move unit to airy and colder place
Refrigerant overcharge	Excess charge of refrigerant	Purge out excess refrigerant
Overloaded evaporator	Beverage/Food load on evaporator is in excess	Reduce the food load on evaporator

IV A bottle cooler with the fault created electrical leakage will be given in this exercise. Follow the procedure given below to identify the defects. Electrical leakage and repair/rectify the given bottle cooler.

1 Switch on the given bottle cooler to confirm the reported faults/complaint . Record the identified complaint in record sheet.

2 Using problem tree as better discussed in the exercise for the defects. Electrical leakage, identify and record the possible causes.

3 Follow (SFS) service flow sequence to identify the fault electrical leakage. As and when you identify the defects, record the identified faults in corresponding record sheet.

4 Get the recorded faults verified by your Instructor, before proceeding further.

5 Record trouble shooting chart (TSC) for the probable causes of the defects given in the end of this exercise. Record the remedial measures that you propose to take for identified defects and get checked by your Instructor before going ahead with repairs.

6 Get the given bottle cooler with above fault, get it repaired and rectify with help of remedial measures given in trouble shoot chart. Record your remedial action taken by you to repair/rectify faults along with any components replaced in record sheet.

7 As soon as faults of bottle cooler rectified , get checked the working condition of bottle cooler in respect of its initially reported fault.

8 Once fault identified and repaired, carryout the electrical general servicing of bottle cooler and test bottle cooler for its working condition.

9 After repairs of the reported faults Incase any other fault exist, record the fault in record sheet and consult your Instructor.

Service Flow Sequence for 'Electrical Leakage'

1 Check for proper earthing. Check for compressor ground.

- Heavy starting current being drawn at each cycle
- Low voltage / High voltage

2 Check for short circuit
   - Loose electrical connection
   - Overheated and melted cable
3 Check for incorrect electrical wiring
   - Circuit grounded to the frame of cabinet
   - Tapping of phase and neutral lines in correct
4 Check for dampness in the building
   - Due to dampness short circuit in mains
5 Check for condensate around the body
   - Evaporator heavily coated with ice
   - Frost formation over thermostat
   - Defective thermostat
   - Leak in insulation
   - Gasket not sealing properly

Trouble shooting chart for 'Electricity leakage'

Probable defects	Causes/Reasons	Remedial measures
Improper earthing		
Compressor grounded	Heavy starting current being drawn at each cycle Overload tripping relay does not open the start winding low/High voltage	Install separate line breaker or a suitable voltage stabilizer
Short circuit	Loose electrical connection Overheated and melted cable Cable Insulation weak	Tighten electrical connection Change good quality cable
Wrong electrical wiring	Circuit grounded to the frame of cabinet Phase and neutral lines, tapping incorrect	Make correct wiring in mains
Dampness in the building	Short circuit in mains	Isolate and insulate main switch
Evaporator heavily coated with ice	Condensate around body of unit Frost formation over thermostat Defective thermostat	Change thermostat
	Leak in Insulation Gasket not sealing properly	Fill gap of insulation Change/repair gasket

Record Sheet

Bottle Cooler

System make: Model: Year:

Reported defects/complaint :

Identified complaint/fault :

Sl.No.	Defects identified	Reasons for defects/ replacement	Remedial measures/ repairs taken	Parts/component replaced

Condition of bottle cooler after repairing the reported defects:

Time taken to repair the reported defects:

Remarks /Additional information :

Trainee: Instructor:

Record Sheet

Visible Cooler

System make: Model: Year:

Reported defects/complaint:

Identified complaint/fault:

Sl.No.	Defects identified	Reasons for defects/ replacement	Remedial measures/ repairs taken	Parts/component replaced

Condition of bottle cooler after repairing the reported defects :

Time taken to repair the reported defects :

Remarks /Additional information :

Trainee: Instructor:

Evacuation, flushing with dry nitrogen, retrofit the machine with HFC 134a, R-600a, R-290

Objectives: At the end of this exercise you shall be able to
- **evacuate the bottle cooler**
- **repair, flush the system and replace necessary system components**
- **replacing electrical devices**
- **charge with HFC refrigerant**
- **seal the process tube**
- **test leak and check the performance of bottle cooler.**

Requirements

Tools/Instruments

- Double end spanner - 1 Set.
- Spanner set open end and ring type 19 to 31.8 mm - 1 Set.
- Insulated crimping tool and lugs for crimping - 1 Set.
- Multi grip plier and general purpose pliers - 1 Set
- Ratchet spanners 6.4 to 10 mm - 1 Set.
- Screw driver, plastic handle 6mm to 150mm - 1 Set.
- Pinching pliers/pinching tool - 1 No.
- Tube cutter deburring tool - 1 No.
- Digital multimeter - 1 No.
- Line tester 500 volts - 1 No.
- Tong test - 1 No.
- Multimeter (clamp on) - 1 No.
- Capillary tube cutter - 1 No.
- Fire extinguisher (Dry powder type) - 1 No.
- Nitrogen cylinder with two stage regulator - 1 Set.
- Brazing kit with oxy-acetylene cylinders - 1 Set
- Gauge manifold - 1 No.

Equipment/Machines

- Refrigerant Recovery unit CFC-12 with recovery cylinder - 1 No.
- Vacuum pump(2 stage) with 2 meters extended electric cord - 1 No.
- Visible cooler with CFC charge having with any major faults - 1 No.
- Electronic weigh scale (approx 2 kgs) - 1 No.

Materials

- Refrigerant cylinder Hydrocarbon blend in a safe container - 100 g.
- Soap solution and sponge - 1 Set.
- Brazing filler rods and flux - 5 Nos.
- Sealed components like Thermostats, Door switches, Lamp holders, Sealed over load protector and PTC relay for compressor - 1 Set.
- HFC 134a gas cylinder - 1 No
- Capillary tube required size - 1 coil.
- POE oil - 1 No.

PROCEDURE

TASK 1 : **Evacuate the Bottle cooler system**

1 Before evacuating clean all joints tested with soap solutions.

2 Connect two stage rotary vacuum pump to the interconnecting manifold valve using hoses to the charge line and the system.

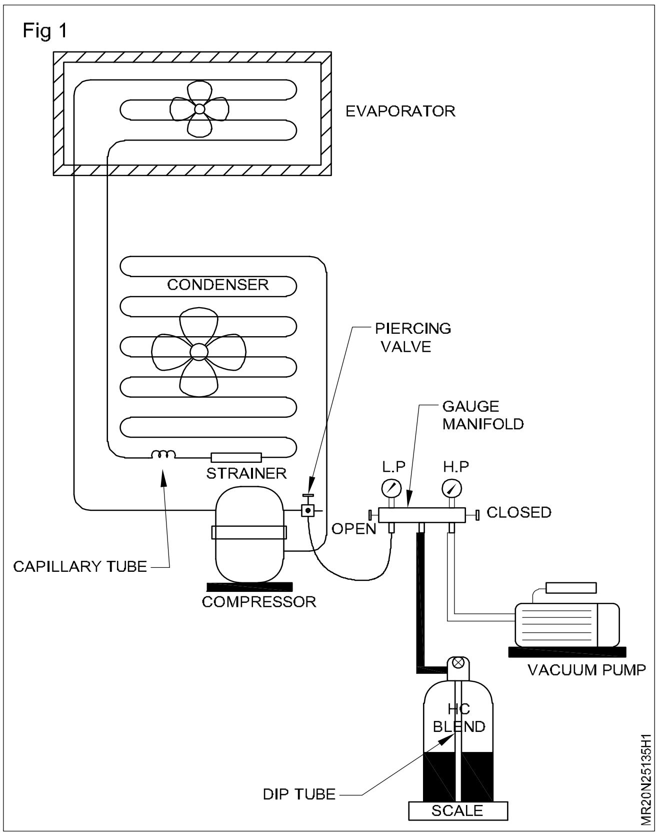
3 Purge out 2 psi dry nitrogen left in the system.

4 Start two stage rotary vacuum pump and allow to run until a vacuum of 5 microns reaches.

5 Break the vacuum for 10 to 15 minutes and study the gauges to know that the system hold 5 microns vacuum. Close both inlet and outlet valve of the manifold valve.

6 Dismantle and remove hose connecting vacuum pump.

Refer for evacuation Previous Exercise (Evacuation of the sealed system) Evacuate the system using 2 stage rotary vacuum pump with vacuum gauge reading of 756 mm/3milibar to remove moisture and condensable gas before.



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TASK 2 : **Repair, clean flush the system and replace necessary system components**

1 Use HFC 134A designed compressor, having slightly high displacement and some materials are made of plastic which works well with HFC-134a refrigerant.

2 Using tube cutter, cut open suction and discharge line of the compressor to remove the compressor by removing leg bolts using open end spanner and by removing terminals from the compressor.

3 Immediately plug the open end of suction and discharge line discarded from the compressor to avoid moisture entering the system.

4 By using specially designed capillary cutter plier, cut and remove the existing capillary tube. Measure the length of capillary tube using inch tape and record in Table A. Plug the open end of tubing.

5 Similarly remove the existing filter drier from the system and plug open ends of the tubing immediately.

6 Remove condenser from the system by cutting tubing inlet and outlet of condenser using tube cutter, and immediately plug the open ends of the tubing.

Note: A system opened to atmosphere for retrofitting from CFC to HFC must be cleaned properly (by using dry nitrogen) to remove moisture and other impurities. Also HFC operated compressor uses POLYOL ESTER (POE) OIL.

7 By pressurizing evaporator pretested coil with dry nitrogen from one end flush the evaporator for removing moisture and contamination.

8 Pressurize condenser pre-tested coil 20% larger than size used in HFC-134a unit with dry nitrogen similarly and flush condenser for removing moisture and contamination, trace of mineral oil.

9 Pressurize with dry nitrogen new capillary tube 20% more in length than the existing one and flush to remove contamination metal particles and moisture, trace of mineral oil & other impurities.

— — — — — — — —

TASK 3 : **Replacing electrical devices**

The Electrical components for replacement to retrofit visible cooler with Hydrocarbon refrigerant, the appliance should have.

1 Install and replace compressor relay with better Insulated PTC relay

2 Change overload protector with sealed device (to prevent sparking)

3 Replace thermostat with sealed type or in case of non availability relocate in a sealed electrical box

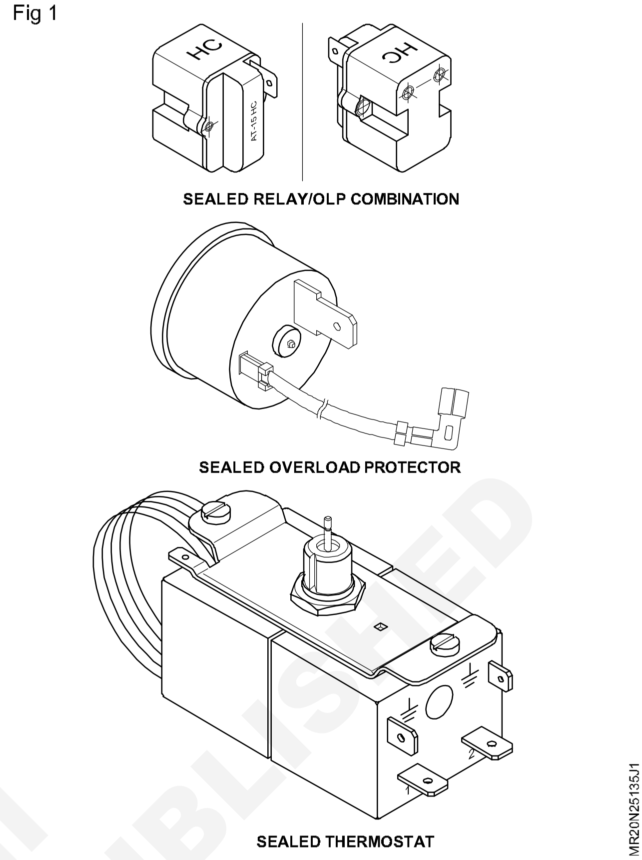
4 Replace ON/OFF and door switch with an sealed type

5 Change lamp holder with sealed type

6 Use standard capacitors and induction type fan motors which are very safe to use with HC'S and they do no spark.

7 Remove unnecessary wires, bring and relocate to top of Visible cooler, make connection with spades. Tie with a plastic sleeve. (Fig 1)

Fig 1



TASK 4 : **Recover CFC (R12) filled visible cooler**

Recovering refrigerant CFC-12 from Visible cooler using an external recovery machine

1 Evacuate recovery machine both from inlet and outlets ends before being connected to the system and ensure the compressor and motor of recovery units are suitable for recovering R-12.

2 Evacuate the empty recovery cylinder before placing it on the weigh scale. Place the empty cylinder on weighing machine and note its weight and record weight in Table - I.

3 Position piercing valves over the compressor process tube and filter drier process tubes as shown in Fig.1

4 Connect the outlet of the piercing valves, using charging hoses to A and C on the gauge manifold, ensure valve L and H are closed.

5 Connect the ends of hose 1 to 'B' port gauge manifold and inlet valve (v1) of recovery machine.

6 Connect the ends of hose 2 to the outlet valve (v2) of recovery machine and outlet valve of a recovery cylinder.

7 The system and recovery machine have not been hooked up for operation.

8 Pierce compressor process tube with piercing valve P1 and purge the gas at 'A' before, retightening. Repeat the same exercise for P2 and purge at 'C'.

9 Open valves L & H and purge hose H1 at I (inlet to recovery machine)

10 Open inlet valve V1 of recovery machine. Start the recovery machine and purge the hose H2 at D before opening the valve of the recovery cylinder.

11 Continue running the recovery machine till the machine stops by tripping at its low-pressure cut out.

12 Immediately close the cylinder valve & record the weight of the cylinder now filled with refrigerant (CFC-12)

TASK 5 : **Charge with HFC refrigerant**

1 Ventilate the area well before charging.

2 Connect the hose to the HFC 134a cylinder to the system.

3 Before opening cylinder valve for charging, weigh the cylinder using electronic weighing machine and record in Table A.

4 Vent a little refrigerant for purging air from the hoses.

5 Slowly open charge line pierce off valve to let HFC 134a refrigerant into the system.

6 Charge approximately 95% of HFC 134a that is usually charged with using CFC-12 Refrigerant andrecord suction pressure as 14 psig and discharge pressure at 200 psig in Table B. (approximately 180CFC x 95%

HFC 134a = 170 grams). (Refer Fig.1 charging bottle cooler using HFC 134a refrigerant).

7 Record the weight from Electronic weighing machine in Table A.

8 Close the cylinder valve and simultaneously close the pierce of valve.

Note: Before charging HFC 134a take care to clean work place, ventilate the area, do not breathe HFC 134a as it is asphyxiates (will suffocate). Also liquid HFC 134a refrigerant will give frost bite (wear gloves, goggles and cover the body to avoid contact with refrigerant). Also ensure the bottle cooler is disconnected from Mains before commencing above exercise. Do not vent excess HFC 134a which has high global warming potential which will have adverse effect on climate.

TASK 6: **Seal the process tube**

1 Remove rubber hose connected to pierce off valve.

2 By using pinch off tool, crimp charge line leaving sufficient space away from the point of pierce off valve connected to allow to make another crimp to ascertain 100% leak proof.

3 Remove pierce off valve, check for any refrigerant leak and close the pierced place by brazing.

4 Seal the process tube to retrofit CFC to HC).

5 By using freshly prepared solution of soap and by using clean brush, make clean, tidy strokes with brush dipped in soap solution to all the brazed joints and bends.

6 Wait to make sure that the soap solution does not bubble.

7 If you are quite satisfied there is no leak in the system.

8 Connect the bottle cooler to power supply.

9 Adjust the thermostat to a cooler position.

10 Load the bottle cooler with sufficient food stuffs.

11 Allow the bottle cooler to run for 2 to 4 hours according to its capacity, amount of food stored.

12 Record the temperature of the evaporator and fresh food compartment in Table B using remote sensing bulb thermometer. Label the bottle cooler showing HFC-134a used.

— — — — — — — —

TASK 7 : **Test leak and check the performance of bottle cooler**

Also ensure the bottle cooler is disconnected from Mains before commencing above. Do not vent excess HFC 134a which has high global warming potential which will have adverse effect on climate.

1 Remove rubber hose connected to pierce off valve.

2 By using pinch off tool, crimp charge line leaving sufficient space away from the point of pierce off valve connected to allow to make another crimp to ascertain 100% leak proof.

3 Remove pierce off valve, check for any refrigerant leak and close the pierced place by brazing.

4 Seal the process tube.

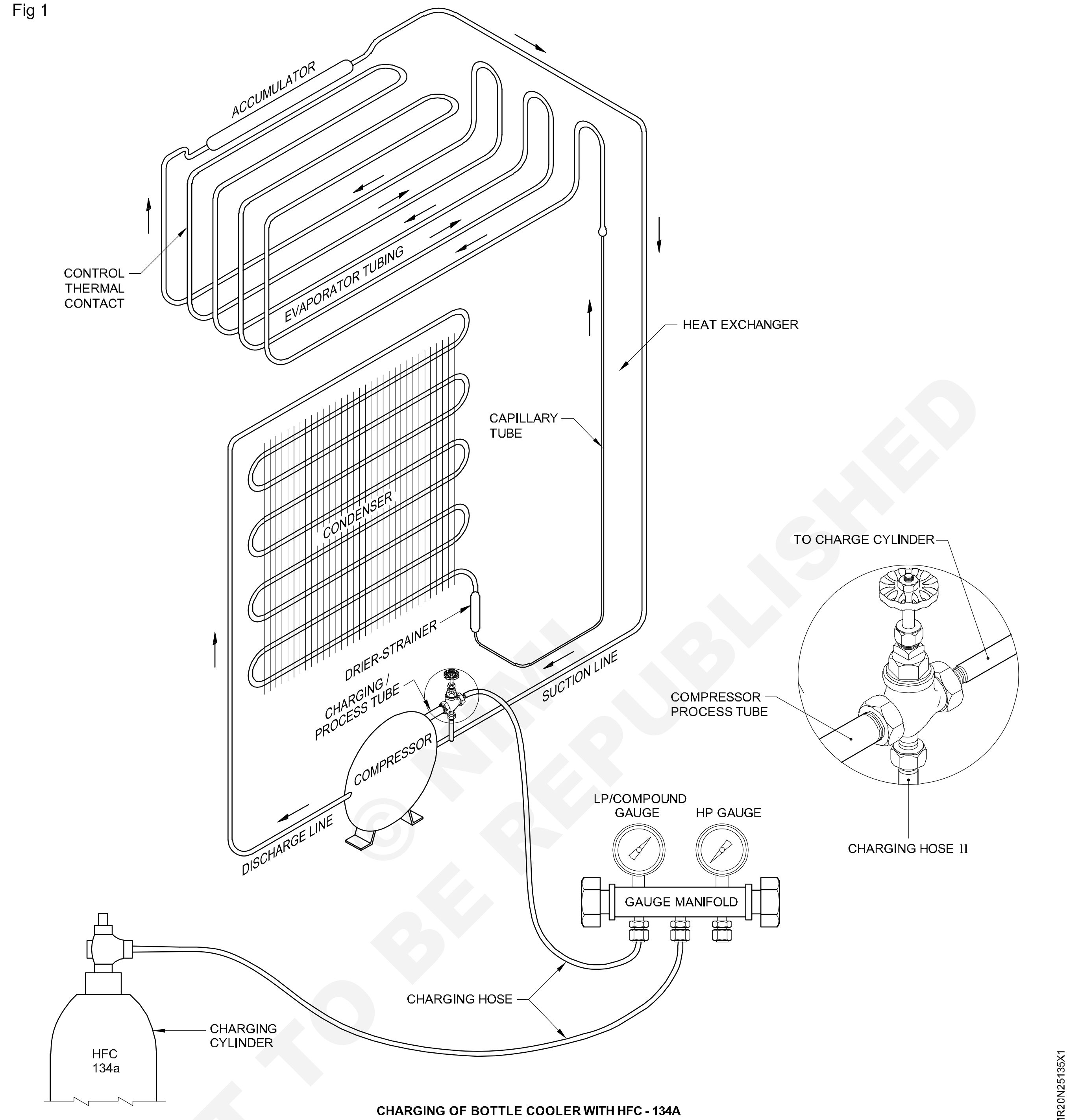
Table 1

Particulars	Weight required	Weight recorded
Weight of the refrigerant R-134a charged	R-134 a R-12 180 grams x R-134a 95% 170 grams - 134 a	R-134 a Filled cylinder weight Charged cylinder weight Weight actually charged

Table 1B

Particulars	Evaporator temperature	Fresh food compartment temperature
After 30 minutes of working	Temperature required 0°C Temperature recorded	Temperature required 10°C Temperature recorded
After 2 to 3 hours of working	Temperature recorded -10°C Temperature recorded	Temperature recorded 2°C to 4°C Temperature recorded

Fig 1



CHARGING OF BOTTLE COOLER WITH HFC - 134A

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Check wiring circuit, test components and replace

Objectives: At the end of this exercise you shall be able to
- **check wiring circuit of bottle cooler test components and replace**
- **check wiring circuit of visible cooler, test components and replace**
- **make wiring of visible cooler.**

Requirements

Tools/Instruments

• Insulated screw drivers	- 1 Set.
• Diagonal cutting pliers	- 1 Pair.
• Wire stripper	- 1 No.
• Voltmeter	- 1 No.
• Multimeter	- 1 No.
• Adjustable spanner 250mm	- 1 No.
• Crimper	- 1 No.
• Line tester heavy duty 500 volts	- 1 No.
• Nose plier	- 1 No.

Equipment/Machines

• An operating bottle cooler with some of all the wiring (leads) missing	- 1 No.

Materials

• ½" insulation tape roll	- 1 No.
• Electrical eyelets	- 1 Box.
• Wiping cloth	- as reqd.
• Solder less connection	- 1 Box.

PROCEDURE

TASK 1 : **Check wiring circuit of bottle cooler, test components and replace**

Check electrical control of bottle cooler

1 Disconnect electrical power and make sure no one turn it ON while the electrical parts/electrical circuit are being removed, repaired or replaced.

2 Avoid electrical shock remember for safety measure and practice it.

3 Test the system with voltmeter to make sure it has no potential (no charged capacitor in circuit)

4 Make sure the material one you standing on is insulated (i.e. wood or concrete).

5 Use tools with insulated handle (this double insures against shock).

6 If damp situation cannot be avoided, wear rubber boots and gloves.

7 Sketch the circuits and parts referring Fig 1 (with the condenser fan) and Fig 2.

8 Position necessary electrical parts in their right place.

9 Clamp or fix the necessary parts before commencing wiring.

10 Test the parts to be fixed.

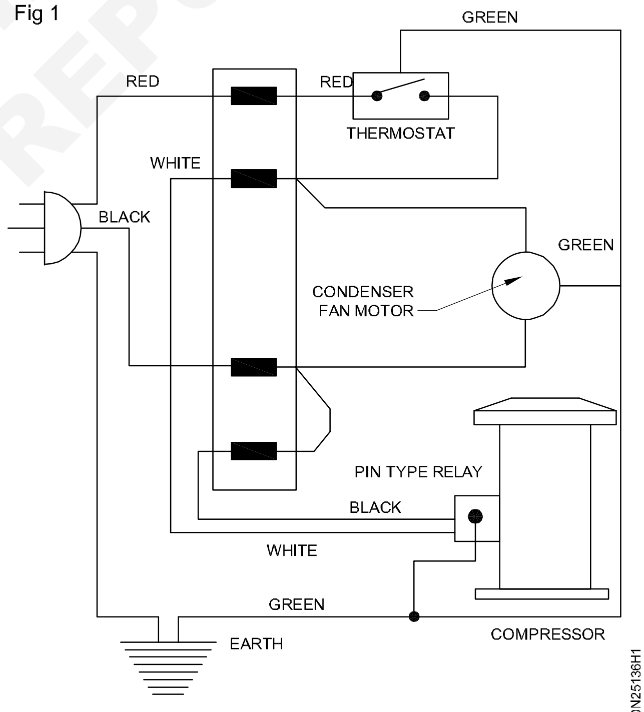
Check and service condenser fan motor of bottle cooler

1 Switch off the bottle cooler.

2 Check physical condition of fan base and body.

3 Disconnect from input supply of fan.

Fig 1



ELECTRICAL CIRCUIT WITH CONDENSER FAN MOTOR

4 Remove base plate bolt from base plate.

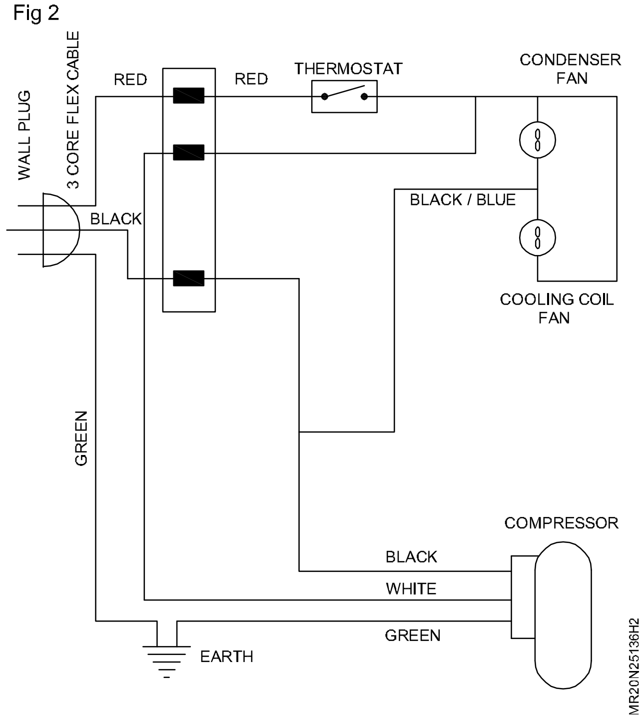
5 Remove fan blade.

6 Clean and remove rust with fine emery paper of fan shaft.

7 Remove all the cover stud.

8 Take out front cover and rotor.

Fig 2



9 Carefully separate stator from back cover.

10 Check winding with multi meter or series lamp.

11 Clean bush/bearing with kerosene oil.

12 Wet bush pocket blanket with mineral oil or fill grease in bearing.

13 Match hole cover with stud cover.

14 Carefully take out connection wire of winding from back cover.

15 Insert rotor and place front cover.

16 Insert stud in cover , tight nut across wise.

17 Check free movement manually.

18 Connect condenser energised motor and observe rotation.

Make wiring of bottle cooler

1 Sketch the circuits and parts referring Fig.1 (with the condenser fan) and Fig 2 (with cooling coil fan and condenser fan).

2 Position necessary electrical parts in their right place.

3 Clamp or fix the necessary parts before commencing wiring.

4 Do not forget to test the parts to be fixed.

5 Prepare new terminals clips required.

6 Cut new wire to the required length.

7 Strip out insulation from each end of the wire without damaging metal.

8 Use same colour code as shown in Fig 1 & 2 to avoid short circuits.

9 Fix new terminals clips identically used on the other wires of the system.

10 Ascertain the wire and terminals clips to be cleaned.

11 Use wire sleeve wherever necessary, likewise alter minals are adequately taped.

12 Do not leave loosely connected terminals clips.

13 Check with ohmmeter each circuit before connecting.

14 Use necessary wire connectors for wire joints.

15 Tie up wires with flexible PVC clamps wherever necessary.

16 Identify that all metals parts are grounded.

17 Use standard chord line for main connection.

18 Use three pin of correct size having 15 amps capacity.

19 Recheck all circuits and connection.

20 Connect electrical system to power and check its operation.

21 Also check each accessory and controls operation.

— — — — — — — —

TASK 2 : **Check wiring circuit of visible cooler, test components and replace**

Check electrical control of visible cooler

1 Disconnect electrical power and make sure no one turn it ON while the electrical parts/electrical circuit are being removed, repaired or replaced.

2 To avoid electrical shock remember for safety measure and practice it.

3 Test the system with voltmeter to make sure it has no potential (no charged capacitor in circuit)

4 Make sure the material one you standing on is insulated (i.e. wood or concrete).

5 Use tools with insulated handle (this double insures against shock).

6 If damp situation cannot be avoided, wear rubber boots and gloves.

7 Sketch the circuits and parts referring wiring plate diagram

8 Position necessary electrical parts in their right place.

9 Clamp or fix the necessary parts before commencing wiring.

10 Test the parts to be fixed.

Check and service condenser fan motor of visible cooler

1 Switch off the bottle cooler.

2 Check physical condition of fan base and body.

3 Disconnect from input supply of fan

4 Remove base plate bolt from base plate.

5 Remove fan blade.

6 Clean and remove rust with fine emery paper of fan shaft.

7 Remove all the cover stud.

8 Take out front cover and rotor.

9 Carefully separate stator from back cover.

10 Check winding with multi meter or series lamp.

11 Clean bush/bearing with kerosene oil.

12 Wet bush pocket blanket with mineral oil or fill grease in bearing.

13 Match hole cover with stud cover.

14 Carefully take out connection wire of winding from back cover.

15 Insert rotor and place front cover.

16 Insert stud in cover, tight nut across wise.

17 Check free movement manually.

18 Connect condenser energised motor and observe rotation.

— — — — — — — —

TASK 3 : **Make wiring of visible cooler**

1 Make sure that the electrical components like compressor, fan motor, thermostat, door switch, tube lights, accessories of compressor (Relay, OLP etc.) are fixed at the appropriate places.

2 Get the appliance manual and find the type of wiring is applicable for the appliance (i.e. (RSIR, CSIR - type. The wiring can also get from the Name plate of the appliance.

3 Copy the wiring on a clean white paper for reference when doing the wiring.

> **Prepare the wires with terminals.**
>
> **It is advised to ensure the continuity between both ends of all types of wires. Use multimeter /continuity tester to check the continuity of wires.**

4 Measure the distance between the components being wired with using a measurement tape.

5 Cut the wires (Red/Black/Blue/Green) as per required length using a cutting plier.

6 Strip (5 mm length) the insulation (PVC layer) at both ends of the wires.

7 Cut the PVC hollow sleeves to number (required quantity) of pieces each has 10mm length using a wire stripper.

8 Put/insert the sleeves into the both ends of the wires.

9 Twist the wire strands of the open end at clockwise direction using a cutting plier.

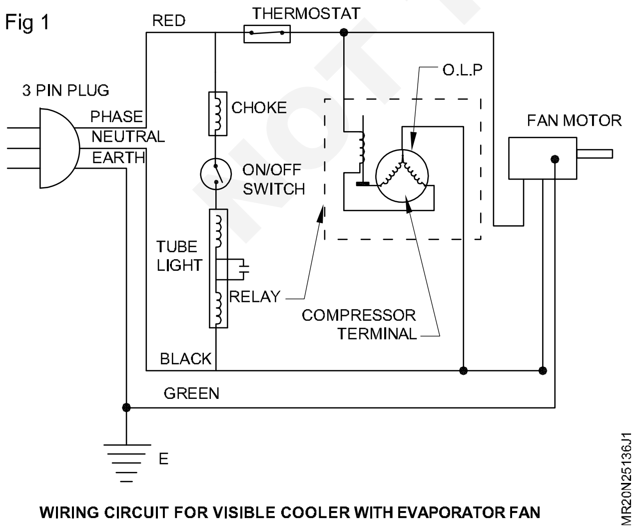
10 Take 'Red" coloured wire, make continuity (phase) for the accessories like thermostat - Relay, thermostat - Fan motor(s). Use terminal connectors - 10 amps - closed type for making loops.

11 Take 'Black' coloured wire, make continuity (neutral) for the accessories Relay, fan motor (s) to 3 pin plug.

12 Make connection to the other accessories like choke, door switch, tube light as per the diagram; Take 'red' wire from the 13 pin plug to thermostat and choke/ door switch parallel. Complete the continuity between accessories as per the diagram.

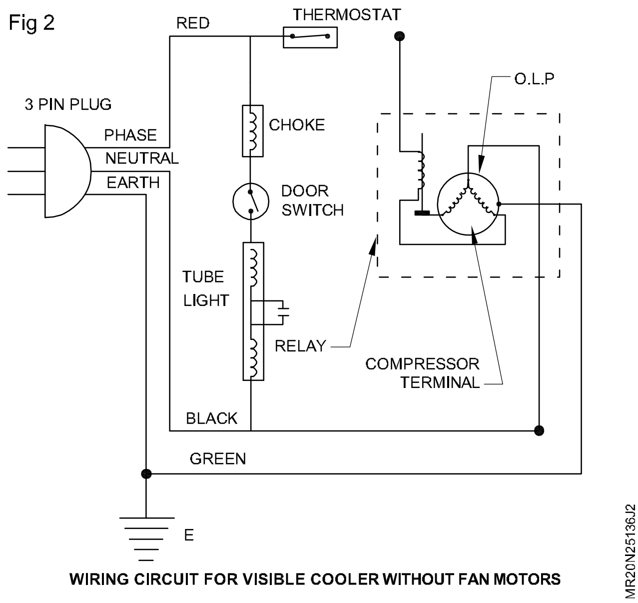
14 Take 'Green' coloured wire from the 3 pin plug and connect it to fan motor leg bolts/compressor leg bolts forming each connection.

Fig 1



WIRING CIRCUIT FOR VISIBLE COOLER WITH EVAPORATOR FAN

Fig 2



WIRING CIRCUIT FOR VISIBLE COOLER WITHOUT FAN MOTORS

Install and test performance of the machine

Objectives: At the end of this exercise you shall be able to
- **install and test performance of a bottle cooler**
- **install and test performance of a visible cooler.**

Requirements

Tools/Instruments

- Tong tester 0-30 amps 0-500 volts. - 1 No.
- Adjustable wrench 250 mm - 1 No.
- Spirit level 200 mm - 1 No.
- Thermometer 0 to 100°C - 1 No.
- Line tester, heavy duty 500 volts - 1 No.
- Measuring tape 3 m graduation in mm - 1 No.
- Nail pulling hammer - 1 No.
- Hammer ball peen 250g - 1 No.

Equipment/Machines

- Bottle cooler (in working condition) - 1 No.
- Visible cooler - 1 No
- Vacuum cleaner - 1 No.

Materials

- Wax polish (20g) - 1 Box.
- Clean foam - 1 Piece.
- Soft cleaning cloth - ½ Sq.m

PROCEDURE

TASK 1 : **Install and test performance of a bottle cooler**

Inspect and select the location of bottle cooler

1 Inspect the place where the bottle cooler has to be installed must be free from dust and dirt.

2 Check the floor on which the unit to be installed must be even surface.

3 Check the level of the floor using spirit level.

4 Confirm the place where the unit to be installed should be away from heat radiation.

5 Also check the location the bottle cooler to be installed should have sewer to drain tank.

6 Select the place away from direct sun source heat.

7 Inspect the place which is nearer to the electrical plug point which confirm and suits necessary standard.

8 Select the place well ventilated for unit installation.

9 Check the place and confirm the place of installation is not below the stair case.

10 Select and mark the place for bottle cooler installation to be approximately 1 foot away from the wall.

11 Make sure the electrical plug point already inspected should have supply of 230 volts ± 5%.

Unpack the bottle cooler

1 Inspect the unit in packed condition for any visible damage that may affect the external body of bottle cooler.

2 Remove nails from the top side of wooden crate using nail remover or cow bar.

3 Remove nails from all the four side of the wooden crate using nail remover/cow bar.

4 Pull out top wooden crate by tapping side ways and bottom side.

5 Pull out all sides wooden crate by tapping with hammer.

6 Remove filters from all the four corners.

7 Remove packing material like (thermocole) kept in between wooden and the unit.

8 Lift the unit slightly upward and unscrew the wooden crate base bolts.

9 Finally remove plastic covering from the unit.

10 Store the unpacked material safely for future shipment or transfer of the bottle cooler.

11 Inspect the external body of the bottle cooler for any scratches, dents or other damaged.

12 Check and inspect the unit for any system damage like kinks and any other major damages.

13 Check after all unit found to be fit for installation, continue the exercise to install the bottle cooler.

Correct positioning of bottle cooler

1 Check before installing or correct positioning bottle cooler, check and note down compressor model, make and other specification required along with circuit diagram and record sheet given.

2 Install the bottle cooler on a flat (plain) surface, without any hindrance of seating and legs.

3 Using spirit level, check if the bottle cooler is kept perfectly positioned.

4 Evaluate the place of installation should be free from sun radiation.

5 Leave at least 1 ft. space clearance on all the sides where the bottle cooler has to be installed.

6 Also evaluate there is no heat source near the bottle cooler.

7 Ascertain there is plenty of air-circulation where bottle cooler has been installed.

8 Check the power supply point is nearby, reachable and to the distance to the length of cord (electric) supplied with bottle cooler.

9 Connect the drain to the sewer.

10 Instruct the owner/user to various methods of handling of the bottle cooler during its usage.

11 Continue the exercise to continue to commission the unit.

Operate and check the performance of bottle cooler

1 Check the power supply available to the unit is within the operating level using multimeter.

2 Connect the bottle cooler to power supply and start the unit.

3 Allow the unit with sufficient load for 2 or 3 hours.

4 Install suitable voltage stabilizer with step up and step down transformer and high voltage and low voltage cut out resetting switch, to safeguard the bottle cooler.

5 Check the door gasket (for bottle cooler with lid) for any air leaks.

6 Check the cabinet temperature using dial type thermometer and record in Record Sheet.

7 Likewise check the performance of thermostat for various graduation cut-in and cut-out temperatures.

8 Check the vibration and noise level of the unit.

9 Check the current drawn by the compressor using an ammeter/ multimeter.

10 Check the condenser fan motor performance by feeling the air throw on condenser surface.

Record Sheet

Unit condition before unpacking External damage Minor/Major
Type of damage

Unit condition after removing packing Internal damage Minor/Major
Type of damage

Special remarks : Unit received in good condition Yes/No

Make ....

Year of manufacture ....

Model number ....

Total capacity ....

Fan motor number ....

Wiring detail ....

Fan H/P .... RPM .... CFM .... AMPS .... Volts ....

Compressor model ....

Volts .... Amps ....

Thermostat Operation

	Temperature °C Cut-in	**Temperature °C Cut-out**	**Remarks**
Medium cool			
High cool			
Low cool			

Overall general performance ....

Technician remarks and initial ....

Engineer's remarks and initial ....

Customer 's Signature

— — — — — — — —

TASK 2 : **Install and test performance of visible cooler**

Select the location for installation

Read and follow the instructions as per in installation/instruction manual which is provided by the company along with the appliance/unit.

1 Make sure the place where the appliance/unit is going to be located.

2 Make the location clean and dust free using a vacuum cleaner.

3 Prefer the location which is nearby windows, ventilators etc.

4 Make sure the location away from heat emitting devices such as gas stoves, electric ovens, direct sunlight etc.

5 Check the floor level of the location for flat even surface using a spirit level meter.

6 Make electrical plug point available near to the location.

Unpack the appliance/unit

1 Bring the unit (with packing) near to the location.

Keep the unit always upright position.

2 Cut packing tape/strip using a wire stripper/cutting plier.

3 Remove the packing materials (thermocole/ thermorexine/plastic sheets) from the carton box carefully.

4 Remove the packing outer cover (carton box) with care.

5 Remove the base packing very carefully and slowly.

One person should lift the unit slightly from the bottom. Next person should hold the unit top side. Another person should remove the base packing.

6 Keep away the packing materials from the location.

Inspect and position the appliance/unit

1 Keep the unit in upright position on the location.

2 Watch the exterior finish of the unit carefully for any scratches, bends, dents, etc.

Please report to the company/dealer for any major damages on the unit.

3 Make sure the door opening/closing operation is perfect.

4 Ensure the door gasket is fixing firmly with the cabinet after closing the door.

5 Check the display glass for clarity.

6 Check the tightness of screws/fasteners if found anything externally.

7 Place the unit on the correct location by moving it using its base castor wheels.

Place the unit on the stand, if provided.

8 Open the door and check the interior cabinet for any damages. It must be clean and dry.

9 Place the plastic coated/metal (S.S.) shelves inside.

10 Unscrew the fasteners of cover of the condensing unit. Check the condition of components like compressor, condenser, fan motor (if there), refrigerant lines, etc.

11 Ensure the components of condensing unit are in good condition, particularly no oil traces to be found on the refrigerant tubes.

12 Check the compressor mounting bolts for tightness. Make the tight (if found loose) using a double spanner/ adjustable spanner - proper size.

13 Refix the cover/grills of the condensing unit with the cabinet.

14 Clean the external body of the unit with clean waste cloth.

The waste cloth must be soft and clean and should not have any metal/solid minute particles in it. Presence of these particles may scratch the surface while cleaning.

15 Apply little quantity of wax polish on the external surface of the cabinet. Polish the surface using soft sponge by rubbing the surface gently.

16 Keep a gap of 150mm (minimum) around the unit [(i.e.) both sides, backside and top side] for free air movement.

Operate the appliance/unit.

1 Measure the voltage supply in the socket by using the tong tester. Make sure that the voltage available is within the operating range (190V-240V) and has no fluctuation.

- **Connect a suitable capacity voltage stabilizer, if the voltage is not within the limit or it is fluctuating.**
- **Make sure that the stabilizer has got time - delay facility (3 minutes).**
- **It is always good providing a voltage stabilizer to the unit for saving the life of electrical components/accessories.**

2 Check the socket for proper earthing.

3 Check the phase line available from the socket using a on-line tester.

Normally the phase line would be given right side pin of the socket.

4 Connect the electrical power line (3 core) of the unit to the socket through the 3 pin plug top.

5 Make sure that the door of the unit is kept closed.

6 Switch 'ON' the unit.

7 Open the door and feel the cool air flow inside (if the evaporator is forced convection type) the cabinet (top side, before the fan). If the evaporator is plate type, feel the cooling effect by touching the hand on the evaporator surface.

Cooling effect will take place after 2-3 minutes from the time of switch 'ON'.

8 Ensure the cabinet light glows during the door kept open.

9 Make sure that the unit is working well and close the Door

Record the technical parameters.

1 Open the door and set the thermostat to 'Normal' position by adjusting its control knob.

2 Keep the dial thermometer with sensing bulb on the middle shelves.

3 Close the door and start filling the tabular column which is given in the record sheet.

4 Take the readings for every10 minutes, till the unit gets trip by the thermostat. Note the cutout temperature.

5 Wait till the unit gets ON, note the cut in temperature.

6 Fill the values in the Record Sheet.

Never disturb the unit until completing the observation process.

Record Sheet

Appliance Make .... Model .... SI.No. ....

Cooling capacity ....

Make sure the following and put () mark, wherever applicable

Compressor type - Hermetic - Reciprocating/Rotary

Condensor type - Air cooled - Natural convection/forced convection

Evaporator type - plate type/finned forced convection

Unit found in good physical condition

Unit located on well place

Unit working satisfactory

Performance Status

SI. No.	Time	Cabin temperature	Supply Voltage	Current Drawn	Thermostat operation		Remarks
	Hrs. Min.	Degree C	Volts	Amperes Degree C	Cut out temperature Degree C	Cut in temperature	
1							
2							
3							
4							

Checking and servicing of horizontal and vertical deep freezer

Objectives: At the end of this exercise you shall be able to
- **identify parts / components in deep freezer / display cabinet**
- **identify controls in deep freezer / display cabinet**
- **service outer body of deep freezer**
- **service inner body of deep freezer**
- **service the system of deep freezer**
- **test run the deep freezer.**

Requirements

Tools/Instruments

- Screw driver 10mm tip, 200 mm length - 1 No.
- Screw driver 3mm tip 150mm length - 1 No.
- Line tester 230V, 500V heavy duty - 1 No.
- Multimeter - 1 No.
- Thermometer dial type remote bulb sensor - 1 Set.
- Allen key set - 1 No.
- Wire stripper - 1 No.
- Soldering iron with lead - 1 No.

Equipment/Machines

- Deep freezer 200/300 its (each) - 1 No
- Chest type freezer - 1 No.
- Upright freezer - 1 No.

Materials

- Goggles, hand gloves - 1 Pair.
- Cleaning cloth - as reqd.
- Clean water & warm water - as reqd.
- Insulation tape, Wire brush - as reqd.
- Soap solution (mild), Motor oil - as reqd.
- Sand paper (medium) - 1 No.
- Paint (Red-oxide, colour) - as reqd.

PROCEDURE

TASK 1 : **Identify parts/ components in deep freezers**

1 Clean surface of the appliance/deep freezer thoroughly with a clean cloth and water.

2 Disconnect the power supply to the appliance by removing the 'plug' from the socket.

1 Keep the appliance/deep freezer on a flat even surface.

2 Make sure that the place is convenient for visualise the unit thoroughly.

3 Observe the parts and identify the labelled parts mentioned in Fig 1.

4 Record the observation in Table - 1.

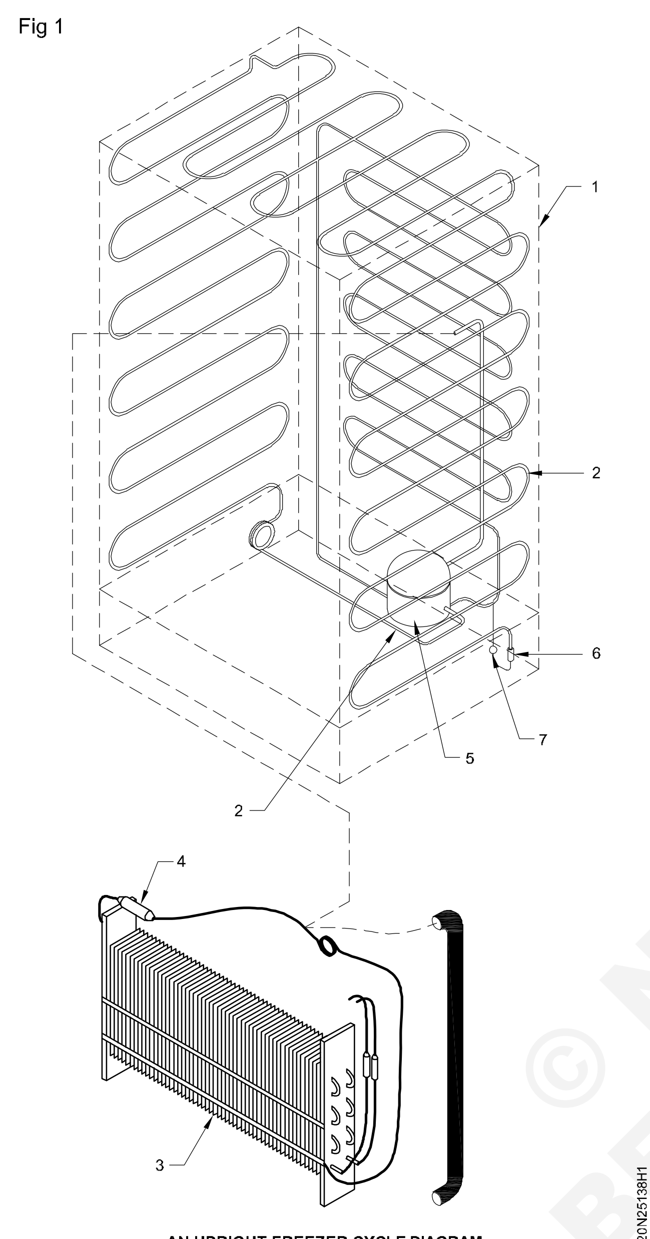
Remove the sheet metal cover of condensing unit (at bottom side) to locate the parts 5 to 7.

Part No.2 cannot be seen directly, unless by removing outer cover sheet metal from the body. Because the 'Freezer' given on the Fig has natural convection skin type condenser. This part can be felt by touching the body surface (feeling warm) when the unit/appliance is working. If the condenser is forced convection type, can be seen at the condensing unit section.

Part No. 3 and 4 can be seen through the inside portion of the unit/appliance, since it is forced convection type.

Table 1 (Refrigeration system parts)

Label No.	Name of the identified part	Specification
1		
2		
3		
4		
5		
6		
7		



AN UPRIGHT FREEZER CYCLE DIAGRAM

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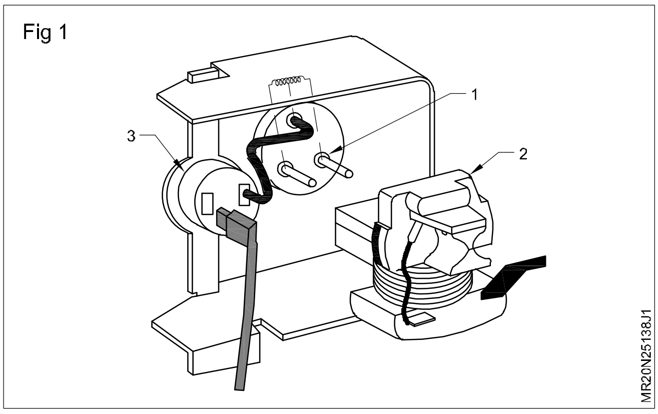
TASK 2: **Identify the controls (Fig 1)**

1 Observe the parts and identify the electrical spares/ controls as labelled in Fig 1.

2 Record the observation in Table - 2.

Table 2 (Electrical parts)

Label No.	Name of the identified part	Specification
1		
2		
3		



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TASK 3 : **Service outer body of deep freezer / display cabinet**

1 Select 165 litres deep freezer

2 Switch OFF the freezer and remove the plug from the socket, if the deep freezer is ON.

3 Move the freezer from existing place to more spacious and workable place.

Do not try to remove the frozen ice with sharp instruments like screw drivers/knives etc.

4 Slightly open the door/lid of the freezer for outer air circulation to come in contact with frozen ice inside deep freezer during the shutdown period.

5 Allow several hours for the unit to completely defrost.

6 Prepare a warm water in a container.

7 Never use hot water for cleaning external surface of deep freezer.

8 Using a clean, soft cloth dipped in warm water, gently wipe the external body of deep freezer until all the dirt and dust gets cleared.

9 Likewise clean the deep freezer door with clean cloth dipped in warm water.

10 Dry out all outer surface of deep freezer with another clean cloth.

11 Do note rub outer surface of deep freezer while cleaning to avoid scratches.

Never use overheated or boiled water and use fresh, clean water, free from dust, dirt and grease. Before cleaning the external surface of deep freezer with warm water, clean external surface with dry soft cloth to remove dust and dirt.

— — — — — — — —

TASK 4 : **Service inner body of deep freezer / display cabinet (Fig 1)**

1 Switch off the deep freezer from power supply.

2 Before commencing above exercise, make sure working place is tidy.

3 Defrost the frozen ice for several hours as the melted water drained out through drain hose.

4 Squeeze out excess water using cloth from the inner compartment.

5 Dry out inner body of deep freezer using dry soft cloth.

6 Mix approximately 25 ml of soap solution in bucket filled with clean and fresh water.

7 Beat the soap solution with water until you get rich foamy lather.

8 Dip and wet clean soft cloth in the prepared soap solution mixed water.

9 Rub cloth dipped in soap solution evenly to all the area of inside deep freezer. Do not leaving any place uncleaned.

10 Using other clean cloth dipped in clean water, wipe out excessive soap solution and other trace of dirt.

11 Repeat above process steps 9 and 10 until all the corners of deep freezer gets cleaned, leaving behind no trace of dirt.

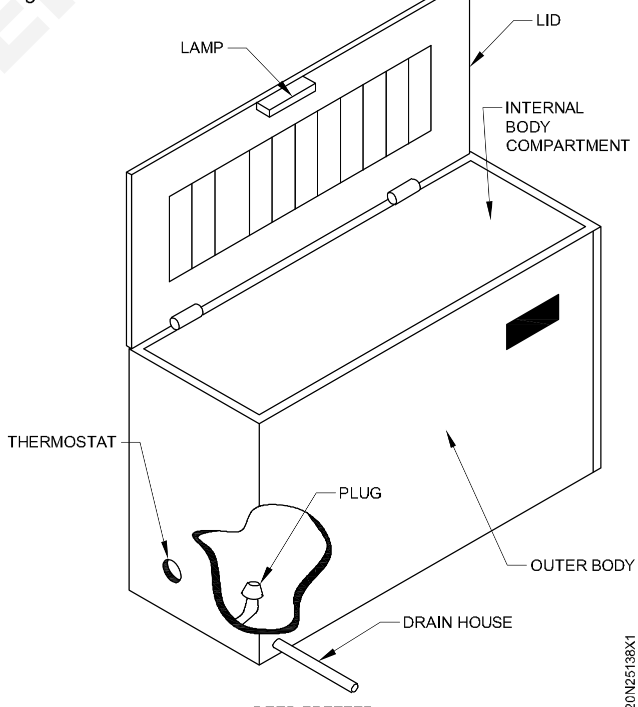
12 Repeat 9, 10 and 11 steps for cleaning door inside compartment.

13 Take precaution, soap solution or water does not enters the bulb holder compartment of the lid (in chest type deep freezers).

14 Dry out all the inside compartment and door inside compartment of deep freezer using clean dry soft cloth.

When shutting down a deep freezer, take special precaution to prevent rusting and to remove odour.

Fig 1



DEEP FREEZER

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TASK 5 : **Service the system of deep freezer**

1 Switch off the deep freezer before commencing above exercise.

2 Keep working area free from dust, dirt and grease.

3 Open the door front housing where compressor is fitted by using screw driver with 10mm tip.

4 Using clean cloth, clean the area adjacent to compressor mounted.

5 Also clean dome and body of compressor using clean cloth.

6 Check the compressor base for any dust.

7 Using cloth wipe the rusted particle and clean the base plate.

8 Using pre-coat red-oxide, paint compressor base.

9 After pre-coat red-oxide gets dried up, apply second coat of colour paint and suitable colour.

10 Now check for any damage fins of condenser.

11 Correct the condenser fins and clean condenser fins and coil using clean water.

12 Check fan motor for oil lubrication.

13 Using oil can, oil the motor with standard calibrated oil.

14 Clean fan motor, fan blade thoroughly with clean cloth.

15 Check the tightness of allen bolt and fan blade, if found loose, tighten the fan blade, allen bolt using allen key.

16 Close the compressor housing front grill cover using screw driver.

— — — — — — — —

TASK 6 : **Test run the deep freezer**

1 Connect the deep freezer to power supply.

2 Check if the deep freezer is mounted or installed correctly.

3 Do not dry run the deep freezer.

4 Partially load with commodities inside deep freezers.

5 Start the deep freezer.

6 Allow the unit to run for 2 hours.

7 Check the compressor amps and record.

8 Check and record freezer compartment temperature.

9 Check and record ambient temperature.

10 Check fan motor speed (checking condenser air flow).

11 Check compressor mounting.

12 Check compressor noise, if abnormal tighten base bolt.

13 Check for vibration of rattling sound, fasten pipe with thin wire to eradicate vibration.

14 Check for overall system performance and note in table 3.

Table 3

Sl. No.	**Particulars**	**Actual reading taken**
1	Compressor amps	
2	Freezer compartment temperature	
3	Ambient temperature	
4	Overall system performance	

— — — — — — — —

Preventive maintenance and trouble shooting

Objectives: At the end of this exercise you shall be able to
- **repair a deep freezer for the symptom 'poor cooling'**
- **repair a deep freezer for the symptom 'no cooling'**
- **check unit trip intermittently**
- **check noise in the system and rectify.**

Requirements

Tools/Instruments

- Ratchet key - 1 No.
- Allen key 1.5mm to 4.00mm - 1 Set.
- Screw driver - 1 Set.
- Cutting plier - 1 No.
- Double end spanner set - 1 No.
- Tube cutter - 1 No.
- Swaging tool - 1 No.
- Flaring tool with yoke - 1 No.
- Vacuum pump 2 stage rotary - 1 No.
- Vacuum gauge - 1 No.
- Oxyacetylene cylinder - 1 Set
- Gauge manifold - 1 No.

Equipment/Machines

- Deep freezer with symptom 'poor cooling'-1 No.

Materials

- Cotton waste - as reqd.
- Wire brush - 1 No.
- Refrigerant cylinder - 1 No.
- Brazing rod with flux - 1 set
- Capillary tube - as reqd.
- Filter strainer - 1 No.
- Door gasket - 1 No.
- Fan blade - 1 No.
- Fan motor - 1 No.
- Fan Motor capacitor - 1 No.
- Puf insulation - as reqd.
- Dry nitrogen cylinder with regulator - 1 No.
- Soap solution in a container

Hints to Instructor: Before starting this exercise the instructor should simulate one or more faults causing the symptom of the fault given in this exercise title. The Instructor may refer the problem tree given in corresponding lesson for some of the possible causes for the faults/complaints. It is therefore suggested that the simulated faults shall be in an increasing order of difficulty as illustrated in problem tree. If the trainee can able to trouble shoot and repair the simulated defects easily and early, simulate another defects/faults and ask the trainee to rectify and so on.

PROCEDURE

TASK 1 : **Repair a deep freezer for the symptom 'poor cooling'**

A Deep freezer, with the defect 'Poor cooling' will be given in this exercise. Follow the procedure given below to identify the defects 'Poor cooling' and repair/rectify the given Deep freezer.

1 Switch on the given Deep Freezer to confirm the reported faults/complaint. Record the identified complaint in record sheet.

2 Using problem tree as better discussed in the exercise for the defects 'Poor Cooling' Identify and record the possible causes. Dismantle the Deep Freezer if necessary.

3 Follow (SFS) service flow sequence to identify the fault Poor Cooling. As and when you identify the defects, record the identified faults in corresponding record sheet.

4 Get the recorded faults verified by your Instructor, before proceeding further.

5 Record trouble shooting chart (TSC) for the probable causes of the defects given in the end of this exercise. Record the remedial measures that you propose to take for identified defects and get checked by your Instructor before going ahead with repairs.

6 Get the given deep freezer with above fault, get it repaired and rectify with help of remedial measures given in trouble shoot chart. Record your remedial action taken by you to repair/ rectify faults along with any components replaced in Record Sheet.

7 As soon as faults of Poor cooling rectified, get checked the working condition of Deep Freezer in respect of its initially reported fault.

8 Once fault identified to repaired, carryout the general servicing of Deep Freezer Assemble and test Deep Freezer fort its working condition.

9 After repairs of the reported faults, In case any other fault exist, record the fault in record sheet and consult your Instructor.

Service Flow Sequence for 'poor cooling'

1 Check the defective compressor
- Compressor not pumping Adequately
- High side pressure is lower than normal
- low side pressure is higher than normal

2 Check for incorrect refrigerant charge
- Under charge of refrigerant
- over charge of refrigerant

3 Check for partial restriction in evaporator
- Accumulation of foreign particles
- Accumulation of Tiny moisture

4 Check for choke in capillary or drier filter
- Strainer filter clogged
- Wax blocked in capillary

5 Check for ice buildup on the evaporator
- Leaky door gasket
- Frequent lid/door opening
- High moist environment
- ice builds up on insulation

6 Check for dirty/blocked condenser and poor condensation
- Condenser Fin blocked by dirt and dust
- High ambient temperature
- Low Fan motor RPM
- Damaged Fan motor blade
- Defective Fan Motor capacitor.

Trouble shooting chart for 'poor cooling'

Probable defects	Causes/Reasons	Remedial measures
Defective compressor	Compressor not pumping adequately High side pressure is lower than normal Low side pressure is higher than normal	Repair/Replace compressor clean system, pressure-test, evacuate (Deep vacuum) and charge system by weight.
Incorrect refrigerant charge	Under charge of refrigerant Overcharge of refrigerant Poor system processing Poor brazing	Charge exact refrigerant by weight Purge excess refrigerant Arrest the leaks
Partial restriction in evaporator	Accumulation of foreign particles Accumulation of tiny moisture	Recover refrigerant clean the system, pressure test, evacuate (Deep vacuum with 2 stage rotary pump), charge the system by exact weight.
Choke in capillary / filter drier	Filter drier clogged Wax blocked in capillary	Change filter drier De-wax capillary or change capillary
Ice builds upon the evaporator	Leaky door gasket Frequent lid/door opening High moist environment Ice builds upon insulation	Repair/Replace door gasket Advise customer not to open lid frequently Shift unit to more airy place Remove breaker strips, stop unit, melt ice and dry
Blocked condenser and poor condensation	Insufficient air movement around condenser Damaged fan motor blade Defective fan capacitor Low fan motor RPM High ambient around condenser	Clean the condenser/fins Allow plenty of air to raise over condenser for good condensation Change fan blade Change capacitor Rewind/replace fan motor Move unit to colder and airy place

Record sheet

1 Name of the unit : Deep freezer

Make : Model: Year :

2 Reported defects / complaint

3 Identified complaint / fault

4

Sl. No.	Defects Identified	Identified reasons for defects	Remedial measures taken	Parts / components replaced

5 Condition of the unit after repairing the reported defects :

6 Time taken to repair the reported defects :

7 Space for additional information :

Trainee : Instructor:

— — — — — — — — —

TASK 2 : **Repair a deep freezer for the symptom 'no cooling'**

1 Switch on the given Deep Freezer to confirm the reported faults/complaint. Record the identified complaint in record sheet.

2 Using problem tree as better discussed in the lesson (theory) for the defects ' No Cooling' Identify and record the possible causes. Dismantle the Deep Freezer if found necessary.

3 Follow (SFS) service flow sequence to identify the fault of deep freezer. As and when you identify the defects, record the identified faults in corresponding record sheet.

4 Get the recorded faults verified by your Instructor, before proceeding further.

5 Record trouble shooting chart (TSC) for the probable causes of the defects given in the end of this exercise. Record the remedial measures that you propose to take for identified defects and get checked by your Instructor before going ahead with repairs.

6 Get the given Deep Freezer with above fault, get it repaired and rectify with help of remedial measures given in troubleshooting chart. Record your remedial action taken by you to repair/ rectify faults along with any components replaced in Record Sheet.

7 As soon as faults of Deep Freezer rectified, get checked the working condition of Deep Freezer in respect of its initially reported fault.

8 Once fault identified to repaired, carryout the general servicing of Deep Freezer Assemble and test Deep Freezer fort its working condition.

9 After repairs of the reported faults , In case any other fault exist, record the fault in record sheet and consult your Instructor.

Service flow sequence of deep freezer for the symptoms 'No cooling'

1 Check for blown fuse
- Undersized fuse
- Low/High voltage
- Loose electrical contacts

2 Check for defective thermostat
- Electrical contacts open
- Improper thermostat settings

3 Check for no refrigerant in the system
- Leak in the system

4 Check for system choke
- Capillary blocked by contamination in refrigerant
- Drier Filter blocked

5 Check for defects in compressor
- Mechanical parts damaged
- Loose wiring

6 Check for low voltage
- Problem in main

7 Check for relay defects
- Electrical contacts open
- Burnt relay

8 Check for overload protector defect
- Electrical contacts open

9 Check for start capacitor defects
- Bulged capacitor

Troubleshooting chart for 'No cooling'

Probable defects	Causes/Reasons	Remedial measures
Fuse blown	Undersized fuse, Low/High voltage	Use correct size fuse Install independent circuit with Auto transformer
	Loose electrical contacts	Tighten electrical connections
Defective thermostat	Electrical contact open Improper thermostat setting	Clean terminal port Set thermostat to cooler position
No refrigerant in the system	Leak in the system Poor brazing	Make proper leak check, evacuation Charge by exact weight and make proper brazing and seal process tube.
	Refrigerant tube rattling	Move tubing and level cabinet due to vibration properly
System choke	Capillary blocked by contamination Drier filter blocked	Replace capillary tube Replace drier filter
Defective compressor	Mechanical parts damaged Winding burnt	Change necessary parts Rewind burnt winding
Low voltage	Problem in mains	Provide circuit breakage before the socket / Install Auto transformer
Defective relay	Electrical contact open burnt relay	Replace relay
Defective overload protector	Electrical contacts open	Change overload protector
Defective start capacitor	Bulged/weak capacitor	Change new capacitors

— — — — — — — — —

TASK 3 : **Unit trip intermittently**

A Deep freezer, with the defect 'Poor cooling' will be given in this exercise. Follow the procedure given below to identify the defects ' Poor cooling' and repair/rectify the given Deep freezer.

1 Switch on the given Deep Freezer to confirm the reported faults/complaint. Record the identified complaint in record sheet.

2 Using problem tree as better discussed in the exercise for the defects 'Poor Cooling' Identify and record the possible causes. Dismantle the Deep Freezer if necessary.

3 Follow (SFS) service flow sequence to identify the fault Poor Cooling. As and when you identify the defects, record the identified faults in corresponding record sheet.

4 Get the recorded faults verified by your Instructor , before proceeding further.

5 Record trouble shooting chart (TSC) for the probable causes of the defects given in the end of this exercise. Record the remedial measures that you propose to take for identified defects and get checked by your Instructor before going ahead with repairs.

6 Get the given deep freezer with above fault, get it repaired and rectify with help of remedial measures given in trouble shoot chart. Record your remedial action taken by you to repair/ rectify faults along with any components replaced in Record Sheet.

7 As soon as faults of Poor cooling rectified, get checked the working condition of Deep Freezer in respect of its initially reported fault.

8 Once fault identified to repaired, carryout the general servicing of Deep Freezer Assemble and test Deep Freezer fort its working condition.

9 After repairs of the reported faults , In case any other fault exist, record the fault in record sheet and consult your Instructor.

Service Flow Sequence for 'poor cooling'

1 Check the defective compressor

- Compressor not pumping Adequately
- High side pressure is lower than normal
- low side pressure is higher than normal

2 Check for incorrect refrigerant charge

- Under charge of refrigerant
- over charge of refrigerant

3 Check for partial restriction in evaporator

- Accumulation of foreign particles
- Accumulation of Tiny moisture

4 Check for choke in capillary or drier filter

- Strainer filter clogged
- Wax blocked in capillary

5 Check for ice buildup on the evaporator

- Leaky door gasket
- Frequent lid/door opening
- High moist environment
- ice builds up on insulation

6 Check for dirty/blocked condenser and poor condensation

- Condenser Fin blocked by dirt and dust
- High ambient temperature
- Low Fan motor RPM
- Damaged Fan motor blade
- Defective Fan Motor capacitor.

Record sheet

1 Name of the unit : Deep freezer

Make : Model: Year :

2 Reported defects / complaint

3 Identified complaint / fault

4

Sl. No.	Defects Identified	Identified reasons for defects	Remedial measures taken	Parts / components replaced

5 Condition of the unit after repairing the reported defects :

6 Time taken to repair the reported defects :

7 Space for additional information :

Trainee : Instructor:

Troubleshooting chart for 'poor cooling'

Probable defects	Causes/Reasons	Remedial measures
Defective compressor	Compressor not pumping adequately High side pressure is lower than normal Low side pressure is higher than normal	Repair/Replace compressor clean system, pressure-test, evacuate (Deep vacuum) and charge system by weight.
Incorrect refrigerant charge	Under charge of refrigerant Overcharge of refrigerant Poor system processing Poor brazing	Charge exact refrigerant by weight Purge excess refrigerant Arrest the leaks
Partial restriction in evaporator	Accumulation of foreign particles Accumulation of tiny moisture	Recover refrigerant clean the system, pressure test, evacuate (Deep vacuum with 2 stage rotary pump), charge the system by exact weight.
Choke in capillary / filter drier	Filter drier clogged Wax blocked in capillary	Change filter drier De-wax capillary or change capillary
Ice builds upon the evaporator	Leaky door gasket Frequent lid/door opening High moist environment Ice builds upon insulation	Repair/Replace door gasket Advise customer not to open lid frequently Shift unit to more airy place Remove breaker strips, stop unit, melt ice and dry

Probable defects	Causes/Reasons	Remedial measures
Blocked condenser & poor condensation	Insufficient air movement around condenser	Clean the condenser/fins Allow plenty of air to raise over condenser for good condensation
	Damaged fan motor blade	Change fan blade
	Defective fan capacitor	Change capacitor
	Low fan motor RPM	Rewind/replace fan motor
	High ambient around condenser	Move unit to colder and airy place

— — — — — — — —

TASK 4 : **Check noise in the system and rectify**

1 Install the given freezer properly.

2 Put the supply cord wire plug in to the wall socket.

3 Switch on the deep freezer.

4 Carefully listen the working sound of the unit.

5 Check any noise is coming then find its location.

6 Check any cabinet vibration noise is observing then check the level of the floor on which deep freezer is resting.

7 Adjust the freezer leg screws to eliminate cabinet noise.

8 Check the working sound and vibration of compressor and rectify it appropriately if necessary.

9 Check the gasket or bleeding of the lid and fix it properly if the lid cereal's vibration sound.

10 Record all the noise hearing spots in a record sheet and also record its remedial measures you have taken to stop or eliminate the noise.

Record sheet

Spot observed	Cause	Remedial measures
Deep freezer cabinet	Improper alignment of the freezer on the floor	Level the floor properly and check with a spirit level adjust the leg screws.
Compressor	Loosed formation bolts	Tight the formation bolt properly.
	Weakened motor winding	Check the motor winding and replace it if needed
Condenser fan	Misalignment Fan leaf bended or spoiled necessary.	Align fan motor properly. Check the fan leaves and correct it if
Electric wires and connectors.	Loose connection	Tight all electric connections, clip the wires properly.

Check wiring circuit test and replace components

Objectives: At the end of this exercise you shall be able to
- **check the electrical parts, components of a deep freezer/ display cabinet**
- **make wiring for a deep freezer/ display cabinet**
- **test run deep freezer/ display cabinet.**

Requirements

Tools/Instruments

- Insulated screw driver - 1 Set.
- Wire stripper - 1 No.
- Adjustable spanner 250mm - 1 No.
- Crimper - 1 No.
- Nose plier - 1 No.
- Line tester (heavy duty) - 1 No.
- Test lamp - 1 No.
- Multimeter - 1 No.
- Tong tester - 1 No.

Equipment/Machines

- Deep freezer (165 litres) - 1 No.

Materials

- Insulation tape - 1 roll.
- Electrical eyelet - as reqd.
- Wiping cloth 30 x 30 cm - 1 piece.
- 4 way 20 amps terminal connectors - 3 Nos.
- PVC insulated copper wire 1 core 2.5 Sq.mm - 10 m.

PROCEDURE

TASK 1: **Check the electrical parts/components of a deep freezer/ display cabinet**

Before commencing the exercise one must have a fair knowledge about electricity and basics principles of motor.

1 Ensure that the electrical circuit is disconnected before starting work and make sure no one turn it 'ON' while the electrical parts/electrical circuits are being removed, repaired or replaced.

2 Locate the condensing unit of the Deep-freezer.

3 Remove the wire guard protecting condensing unit.

4 Locate and identify the starting relay connected to compressor terminals.

5 Remove the start relay from the compressor terminal

6 Use multimeter and check relay continuity

7 Use test lamp and check the centre plunger movement of the relay

8 Use multimeter and check continuity of each winding at compressor terminal

9 Likewise check the grounding of compressor motor.

10 Check the continuity of overload protector with multimeter.

11 Put back relay OLP back in compressor terminal and connect all the heads.

12 Disconnect electrical heads from fan motor.

13 Disconnect start capacitor from the compressor wiring.

14 Short the capacitor immediately after removing from supply, as they store energy.

Never put your hands across the terminals of capacitor as it may give heavy shock.

15 Check the continuity of each winding of the Fan Motor by multimeter

16 Check motor for end plays and the bearing

17 Check Fan Motor for excessive noise

18 Connect the fan capacitor leads or terminals for a second with proper voltage power connection by means of test heads.

19 Remove the test cord and short the capacitors leads.

If the capacitor is good it will spark.

If there is an open circuit within the capacitor, there will be no sparking and if the capacitor is shorted the fuse will blow up.

20 Remove the lid lamp and switch from the circuit

21 Use test lamps and check the continuity of lid lamp holder and switch

22 Disconnect the electrical leads of thermostat and by multimeter check the continuity.

23 Connect the Electrical heads of thermostat and test run the deep freezer.

— — — — — — — —

TASK 2 : **Make wiring for a deep freezer (up right freezers 165 litres)/ display cabinet**

1 Clean the working area.

2 Inspect the hermetic freezer system, locate the wiring diagram

3 Sketch the circuits and parts.

4 Mark the places where new wires (leads) are to be installed.

5 Determine size and type of wire to be replaced.

6 Use same colour code as in wiring diagram

7 Cut new wire to proper length

8 Position necessary electrical parts in their right place

9 Fix the clamp necessary parts before commencing wiring

10 Test necessary components to be replaced/fixed

11 Strip insulation from each end of wire without injuring metal

12 Prepare new terminal clips as required

13 Make sure that both terminals and wire in which terminals to be installed are clean.

14 Fix new terminal clips used identical on the existing wires of the system

15 Do not leave loosely connected terminal clips

16 Check with multimeter each circuit continuity before making connection

17 Use necessary wire connectors for wire joints

18 Make sure all terminals are adequately taped where necessary.

19 Tie up wires with flexible PVC clamps wherever necessary.

20 Give earthing to all metal parts.

21 Recheck all circuits and connections.

22 Use standard chord line for main connection.

23 Use three pin plug of correct size having 15 amps capacity

24 Connect electrical system to power and check the operation of upright freezer for its running condition.

25 Check each controls operation.

— — — — — — — —

TASK 3: **Test run Deep Freezer/ display cabinet**

1 Connect the Deep Freezer to power-supply

2 Partially load the deep freezer with commodities

3 Start the Deep-freezer

4 Allow the unit to run for few hours

5 Check the compressor amperes and record in table1

6 Check Freezer compartment temperature and record in Table 1.

7 Check and record ambient temperature in Table 1.

8 Check the Fan Motor speed.

7 Check the compressor mounting for noise and vibration.

10 Check for overall system performance and record in table-1.

Record Sheet

Date:

Unit details

Unit make : Model No. Serial No.

Capacity : Compressor make Compressor model

Condenser type: Condenser size: Evaporator type: Size:

Service details

Checked Voltage: Fan motor and play: Installation:

Vibration: Noise level:

Compressor relay make: Overload make: Thermostat make:

Thermostat operation: Wiring connections:

Replaced

Terminal clips: Cabinet light/bulb: Door switch:

Fiber washer: Fan blade: Door gaskets:

Components if any:

Lubricated fan motor :

Overhauled the components:

Table 1

Particulars	As per manual	Actual reading taken
Compressor amperes	1.8 to 2.2 amperes at 180/260 volts	
Freezer compartment temperature	- 9°C to - 18°C	
Ambient temperature	32°C average	
Overall system performance	Normal	

Install and test performance of deep freezer

Objectives: At the end of this exercise you shall be able to
- **select location of deep freezer**
- **unpack deep freezer**
- **install the deep freezer**
- **check the performance of deep freezer.**

Requirements

Tools/Instruments

• Tong tester - 0 - 30 amps	- 1 No.
• Adjustable wrench	- 1 No.
• Spirit level 200mm	- 1 No.
• Thermometer 0 - 100°C	- 1 No.
• Line tester heavy duty 500 volts	- 1 No.
• Measuring tape 3m graduation in mm	- 1 No.
• Nail remover	- 1 No.
• Hammer 250g	- 1 No.

Equipment/Machines

• Deep freezer	- 1 No.
• Vacuum cleaner	- 1 No.

Materials

• Wax polish	- 1 Bottle.
• Cleaning cloth	- 0.5Sq.m
• Thermorexine foam	- 1 Sq.m.
• Insulation tape 12mm PVC	- 1 No.

PROCEDURE

TASK 1 : **Select location of deep freezer**

1 Select the place where Deep Freezer has to be installed must be free from dust, dirt etc.,

2 Inspect the place where more quantity of ambient air is available.

3 Select the place not close to cookers, radiators, or other heat generating equipments.

4 Check, if the several unit (Deep-Freezer) are to be installed together, make sure that hot air from one unit cannot pass over the condenser of another unit.

5 Using spirit level, check level both from side to side and from back to front can be levelled properly to avoid noise and vibration.

6 Check the electrical characteristics (socket capacity in amperes) matches with the unit to be Installed.

7 Make sure the electrical plug point with the shortest possible cable and should have supply of 230 ± 5% volts.

— — — — — — — —

TASK 2 : **Unpack deep freezer**

1 Shift the packed Deep Freezer to the place of Installation.

2 Inspect the unit in packed condition for any visible damage that may affect the external body of Deep Freezer.

3 Remove nails from the top side of wooden crate using nail hammer.

4 Remove Nails from all four sides of the crate using nail remover.

5 Pull out wooden crate by tapping on sides and bottom of crate using small 250 grams hammer.

6 Remove card board cover and four corner fillers.

7 Remove plastic cover, if the unit is covered.

8 Slant the unit slightly, remove base bolt of wooden crate base.

9 Check, physically the freezer cabinet.

10 Store original packings for future shifting.

11 Avoid knocking of the planks at the condensing unit.

12 Avoid scratches on the body of freezer.

13 Note compressor's name plate, specification and circuit diagram.

— — — — — — — —

TASK 3 : **Install the deep freezer**

1 Locate and Install the unpacked Deep-Freezer on prepared or anti-vibration mountings.

2 Make sure that the unit is properly secured, and level in both places.

3 Use metal shims where height adjustment is required.

4 Place the freezer atleast 6” (150mm) away from the wall.

5 Make sure that the place has sufficient ventilation.

6 Check all materials and procedures comply fully with the requirements of relevant codes and regulations.

7 Connect the tank drain to sewer in case of chest freezers.

8 Instruct the owner/user of various methods of handing unit during its usage.

— — — — — — — —

TASK 4 : **Check the performance of deep freezer**

Pre start-up checks

1 Confirm that the condenser motor fan (in chest-freezer) are tightly fitted on shaft, rotate freely and rotate in the right direction.

2 Make sure that the bearings of condensing unit fan motor are clean and properly lubricated.

3 By using control circuit, verify operation (sequence of operation) controls and safety Devices with reference to detailed wiring diagram of the unit.

Starting procedures

1 Check the connect of cord manually.

2 Turn the unit main switch to the power cable plug to ON position.

3 Turn the switch of the unit to ON position.

4 Visualize set point.

5 Test run the unit and check starting amperes drawn by unit motor.

6 Check the line voltage.

7 Check the noise and vibration of the unit.

8 Check the working operation of thermostat after 2 to 3 hours of running.

9 Check the running amperes drawn by Deep-Freezer and record in Record-Sheet.

10 Check suction and discharge temperatures under normal usage and record in record sheet.

11 Check the Evaporator or cooling compartment temperatures and record in record sheet

12 Record condenser air inlet and outlet temperature

13 Check Door sealing lid for air leaks

14 Check unit overall performance and note in record table

15 Do not leave the place of Installation until the cabinet to design operating temperature and has correct operation of thermostat and free from noise and vibration.

Record Sheet

Date: Name of the unit: Deep freezer

Model No. .... Sl.No. .... Capacity ....

Put [√] tick marks on the spaces where applicable

1 Unit found in good condition

2 Unit located on well ventilated area

3 Electrical power supply available .... volts

4 **Performance test**

S.No.	**Time**		**Cabin temp.**	**Supply voltage**	**Current**	**Thermostat operations Cut-in**	**Cut-out**	**Remarks**
	Hrs	**min.**	**Deg. C**	**Volts**	**Amps**	**Deg.C**		

5 Unit working satisfactory

Checking and servicing of ice cube machine and its different components

Objectives: At the end of this exercise you shall be able to
- **identify the mechanical components**
- **identify the ice removal system**
- **identify the electrical components**
- **service the ice cube machine.**

Requirements

Tools/Instruments

- Screw driver - 1 No.
- Clamp meter - 1 No.
- Tester - 1 No.
- Double end spanner set - 1 No.
- Combination plier - 1 No.
- Multimeter - 1 No.
- Soldering iron - 1 No.
- Tube bender - 1 No.
- Pinch off plier - 1 No.
- Swaging tool - 1 Set.
- Flaring block with yoke - 1 No.
- condenser comb - 1 No.
- Ball pean hammer - 1 No.
- Nylon hammer - 1 No.
- High pressure gauge - 1 No.
- Low pressure gauge - 1 No.

Equipment/Machines

- Ice cube maker - 1 No.
- Oxy acetylene gas welding kit - 1 No.
- Dry N_2 with 2 stage gas regular - 1 Set.

Materials

- Clean cloth - as reqd.
- Brazing rod with flux - as reqd.
- Caustic soda solution - as reqd.
- Sopa solution - as reqd.
- Sponge - as reqd.
- Water hose with sprayer - 1 No.

PROCEDURE

TASK 1 : **Identify the mechanical components**

1 Arrange the ice cube maker in a convenient place. (Fig 1)

2 Record the details available in the name plate of the machine in a record sheet-1.

3 Identify each parts of the ice cube maker and record it into the identification record Sheet-1.

Record Sheet - 1

Mechanical Components

1 Name lof the unit : Ice cube maker

2 Manufacturer details :

Make : Model : Year

Compressor type and make :

Condenser type :

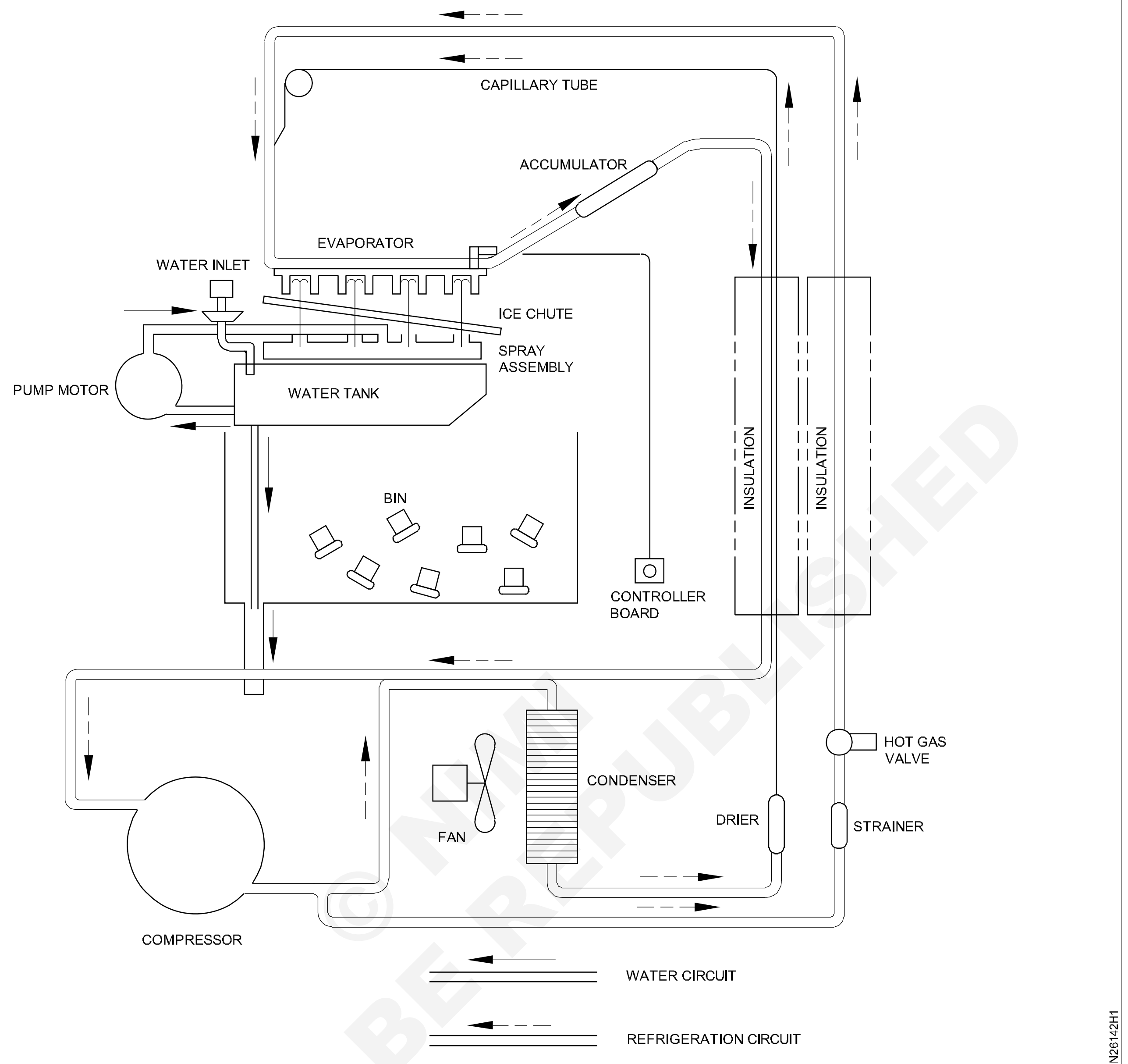
Evaporator type :

Rated current :

Ice cube production/hr :

Identification Record Sheet

Fig 1



WATER AND REFRIGERANT CIRCUIT

Sl. No.	Name of the component	Location	Use	Condition
1				
2				
3				
4				
5				
6				

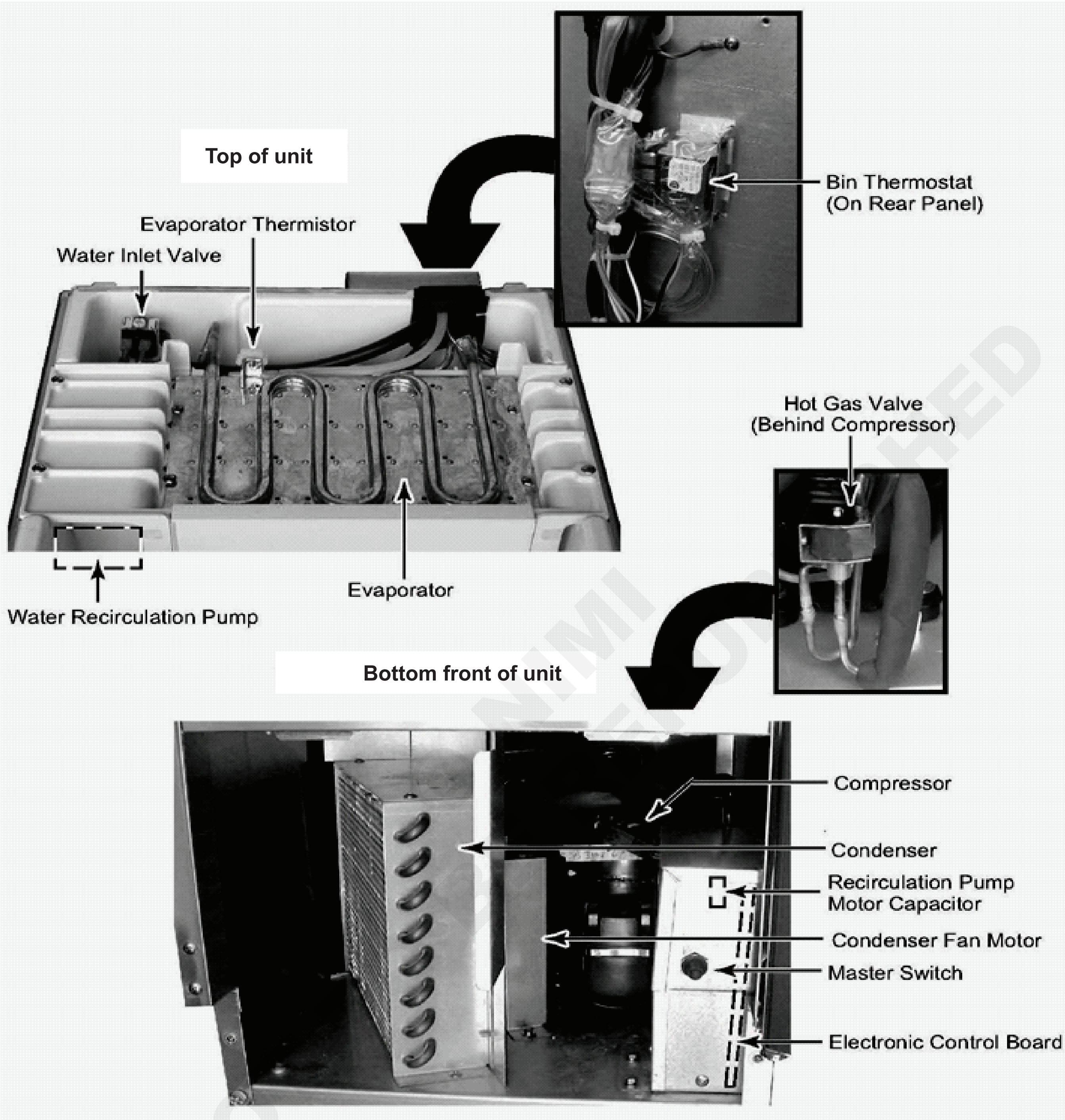
Component Access

This picture helps you to identify each component inside the outdoor automatic ice maker. The components and their locations are shown in Fig 2

4 Fill up the available specification from the user manual into a record sheet - 2 and get it signed by your instructor.

Fig 2

Component Locations



Record Sheet - 2

AC power supply :

Amperage :

Minimum circuit capacity :

Maximum fuse size :

Ice production/24 Hr :

Ambient Temperature (°F/°C)	**Water temperature (°F/°C)**		
	50/10	**70/21**	**90/32**
	51 lbs (23kg)	46 lbs (21kg)	43 lbs (19kg)
	47 lbs (22kg)	40 lbs (18kg)	38 lbs (17kg)
	46 lbs (21kg)	35 lbs (16kg)	32 lbs (14kg)
	40 lbs (18kg)	34 lbs (15kg)	29 lbs (13kg)

Ice shape :

Ice production/cycle :

Storage capacity :

Bin control setting :

Exterior dimensions :

Exterior finish :

Net weight :

Cube control system :

Harvesting control system :

Ice making water control :

Bin control system :

Ambient temperature :

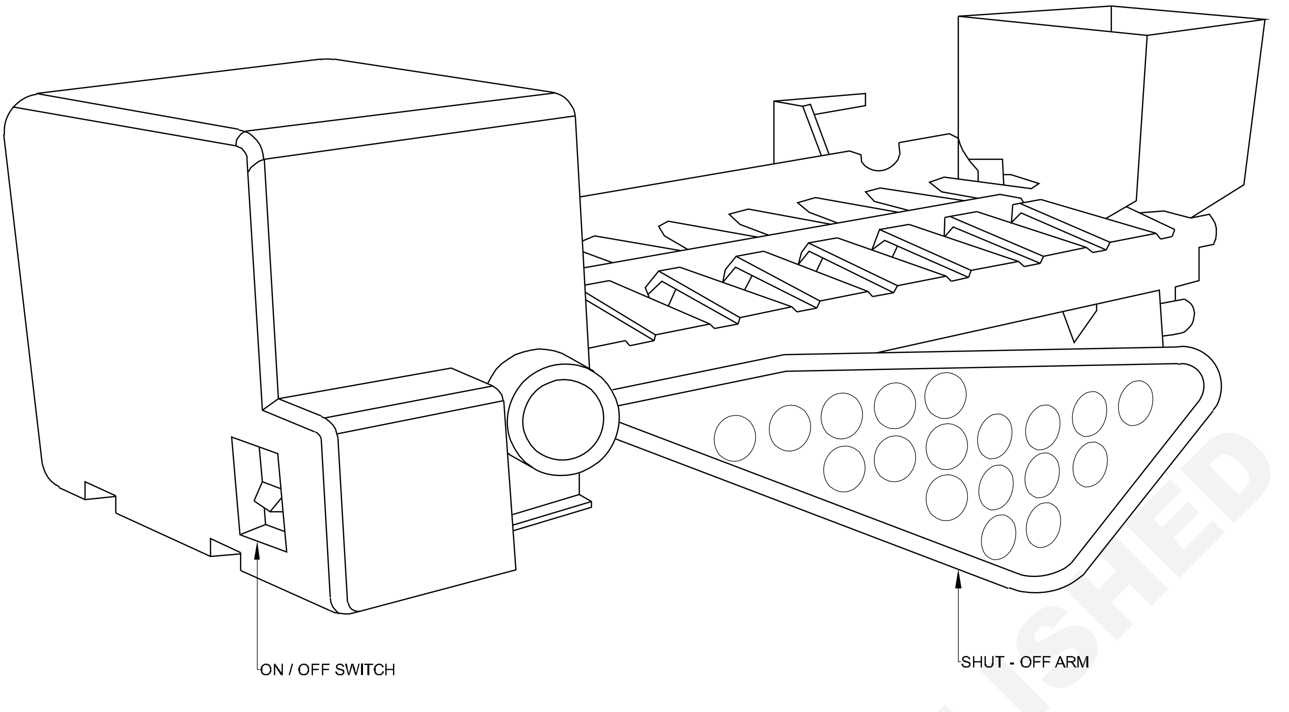
Water supply pressure :

— — — — — — — —

TASK 2 : **Identify the ice removal system**

1 Identify various parts of the ice removal system Fig 3 and record it in a record sheet-3.

Fig 3



Record Sheet - 3

Ice Removal System

Sl. No.	Name of the part	Location	Condition
1	Thermostat		
2	Ice mold		
3	Mold heater		
4	Ice maker motor		
5	Ejector blade & shut off arm		
6	Water fill switch		
7	Timer		

— — — — — — — —

TASK 3 : **Identify the electrical components**

1 Observe the wiring diagram supplied by the manufacturer and identify the flow of current and its working.

2 Draw the wiring diagram and show your instructor and get this signature.

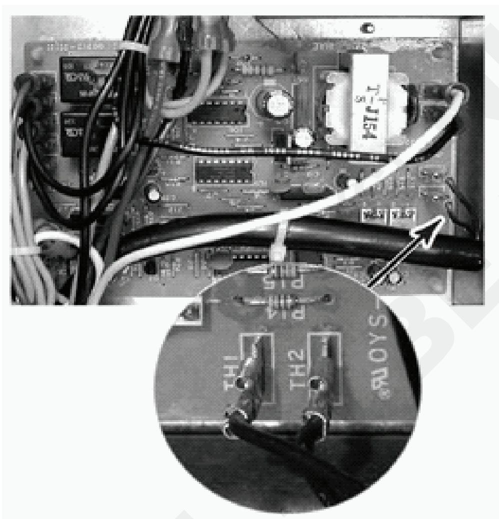
3 Identify all the electrical components fitted in the machine visually and record it into the record sheet-4.

Record Sheet -4

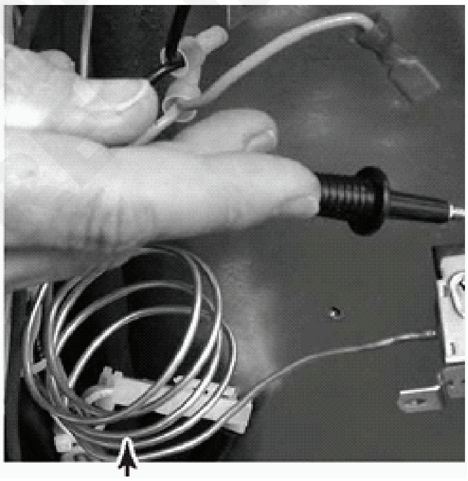
Electrical Components

Sl. No.	Name of the Component	Location	Remarks
1	Bin thermostat		
2	Evaporator thermistor		
3	Water recirculation pump		
4	Water inlet valve		
5	Hot gas valve		
6	Recirculation pump motor capacitor		
7	Master switch		
8	Electronic control board		
9	Solenoid valve		
10	3 Wire connector		
11	Cut wire tie		
12	Wire tie		
13	Mold water		
14	Power cord		

Fig 4

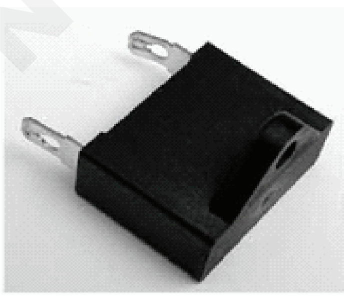


Evaporator Thermistor

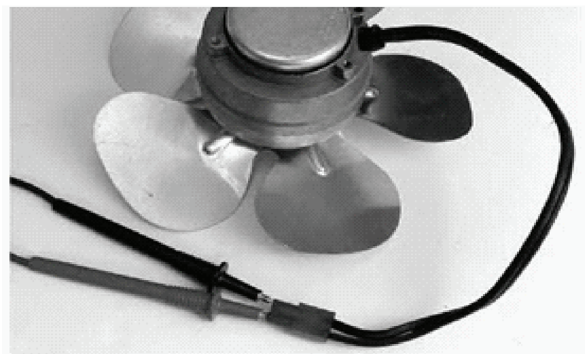


Sensor

Bin Thermostat

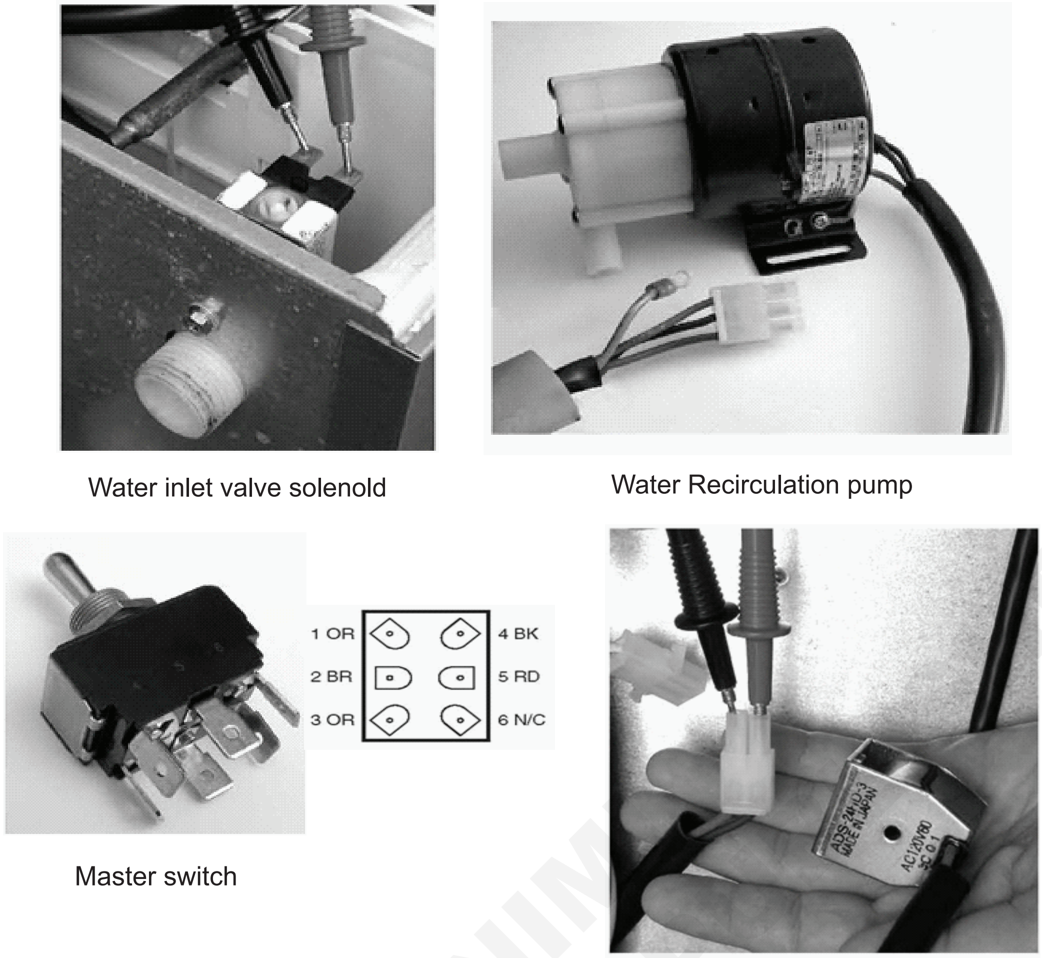


Recirculation pump motor capacitor



Condenser fan motor

Fig 5



Water inlet valve solenold

Water Recirculation pump

Master switch

Hot gas valve solenold

— — — — — — — — —

TASK 4 : **Service the ice cube machine**

Strip out the major components

a Remove the evaporator.

1 Unplug ice maker or disconnect power.

2 Turn off the water supply to the ice maker.

3 Move the ice maker to gain access to the rear of the unit.

4 Disconnect the drain outlet hose from the ice maker.

5 Disconnect the water inlet line from the ice maker.

6 Remove the ice from the storage bin.

7 Remove the ice maker door and the top cover.

8 Remove the top cover.

9 Remove the four screws from the evaporator.

10 Remove the water inlet valve solenoid wires from the terminals and move them out of the way.

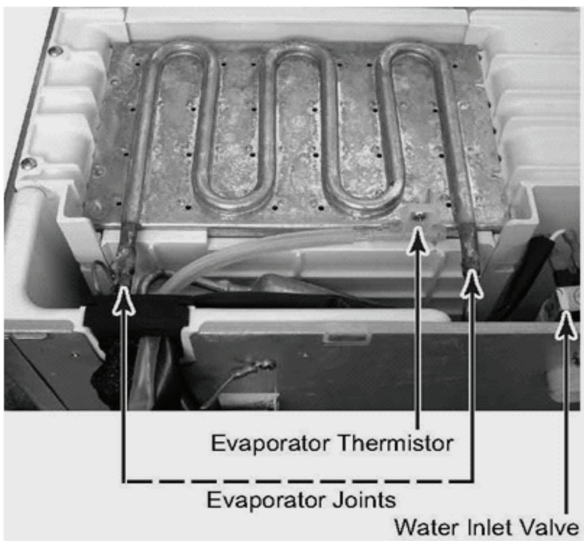
11 Remove the evaporator, thermistor screw and remove the thermistor from the evaporator.

12 Protect the area surrounding the two evaporator joints.

13 Access the sealed system and discharge the refrigerant into an approved recovery system.

14 Un braze the two evaporator joints from the sealed system and remove the evaporator. (Fig 6)

Fig 6



b Remove the water re-circulation pump

1 Unplug the ice maker or disconnect power.

2 Turn off the water supply to the ice maker.

3 Move the ice maker to gain access to the rear of the unit.

4 Disconnect the drain outlet hose from the ice maker.

5 Disconnect the water inlet line from the ice maker.

6 Open the ice maker door.

7 Remove the ice from the storage bin.

8 Remove the stop cover.

9 Remove the ice scoop from its holder.

10 Remove the hex screws from the holder and remove the holder from the unit.

11 Squeeze the locking tabs on the tube clip and remove the tube from the water reservoir.

12 Pull the other end of the tube off the water recirculation pump.

Fig 7

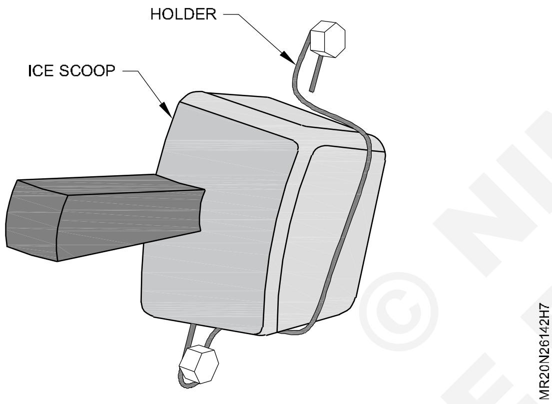
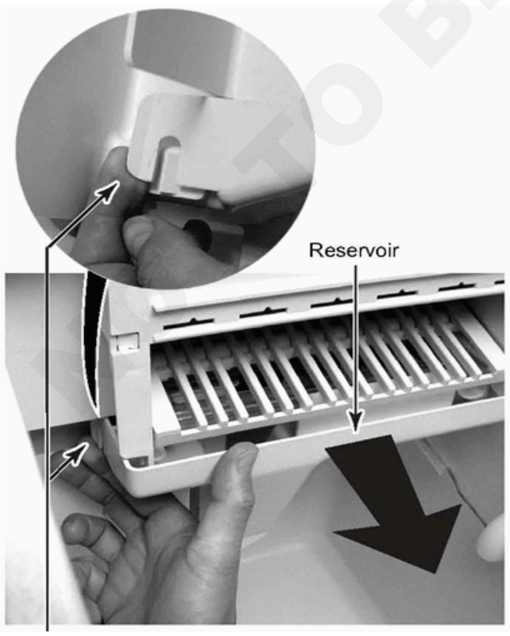


Fig 8



Push locking tap cut (on each side)

13 Push out on the left and right locking tabs and pull the water reservoir out of the unit.

14 Remove the screw from the right side of the water recirculation pump cover. Grasp the drain hose at the bottom of the cover, then pull down and forward and remove the cover from the unit. (Fig 7 & Fig 8)

15 Remove the size screws from the rear channel and remove the cover from the ice maker.

16 Disconnect the recirculation pump 3-wire connector.

17 Cut the indicated wire tie.

18 Remove the green ground wire screw.

19 Remove the four evaporator screws and the four ice making housing screws.

20 Lift the rear of the evaporator and the front of the ice making component housing, then slide the housing under the evaporator toward the front of the unit until the housing clears the evaporator. (Fig 9 & Fig 10)

Fig 9

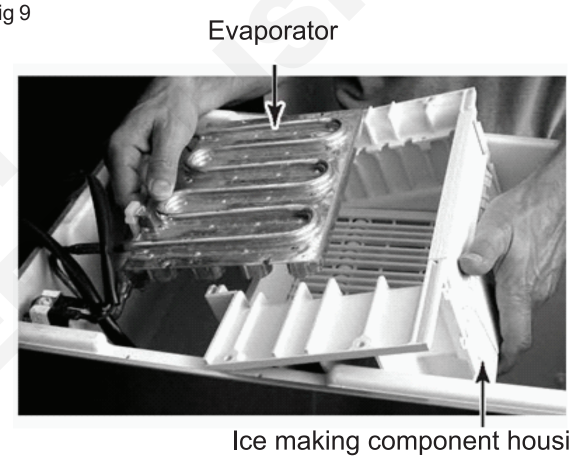
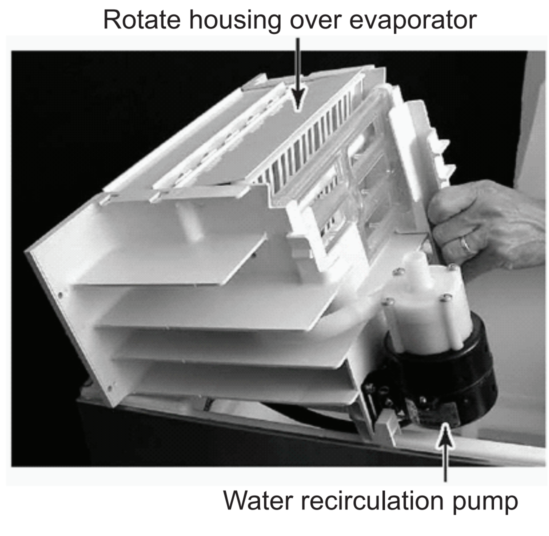


Fig 10

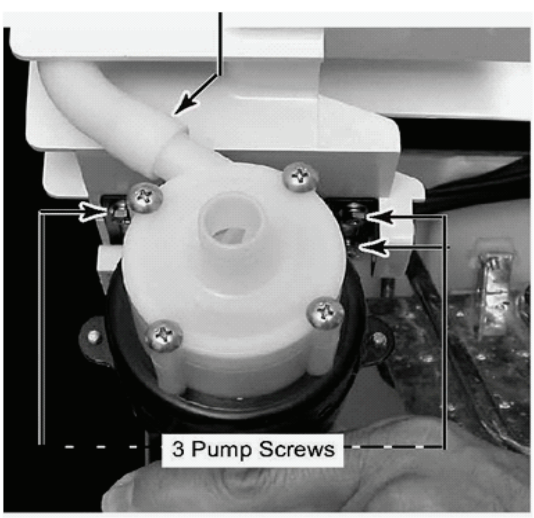


21 Rotate the ice making component housing so you can easily access the recirculation pump mounting screws.

22 Use a 9/23” socket or philips screw driver and remove the recirculation pump mounting screws.

23 Disconnect the end of the water inlet fill tube from the recirculation pump and remove the pump. (Fig 11)

Fig 11



c Remove the water inlet valve

Electrical shock hazard disconnect power before servicing. Replace all parts and panels before operating.

Failure to do so can result in death or electrical shock.

1 Unplug ice maker or disconnect power.

2 Turn off the water supply to the ice maker.

3 Move the ice maker to gain access to the rear of the unit.

4 Disconnect the drain outlet hose from the ice maker.

5 Disconnect the water inlet line from the ice maker.

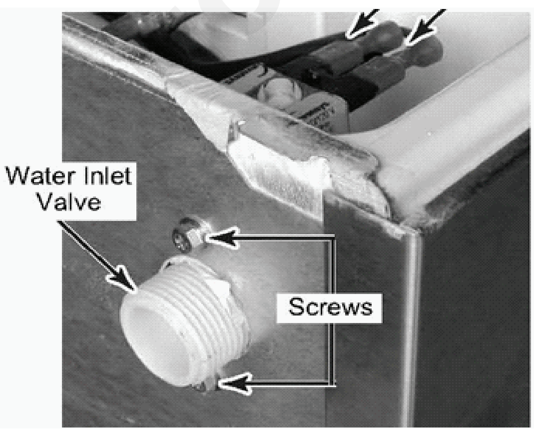
6 Remove the ice from the storage bin.

7 Remove the ice maker door and the top cover.

8 Remove the two screws from the water inlet valve.

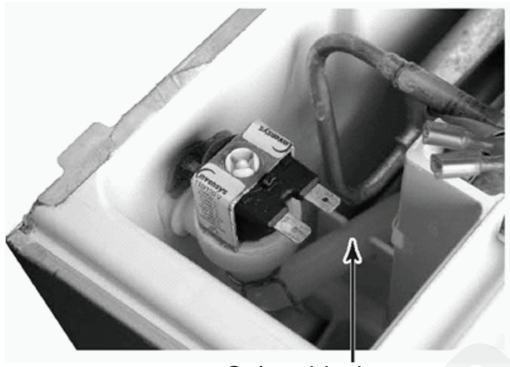
9 Disconnect the two wires from the water inlet valve solenoid terminals. (Fig 12)

Fig 12



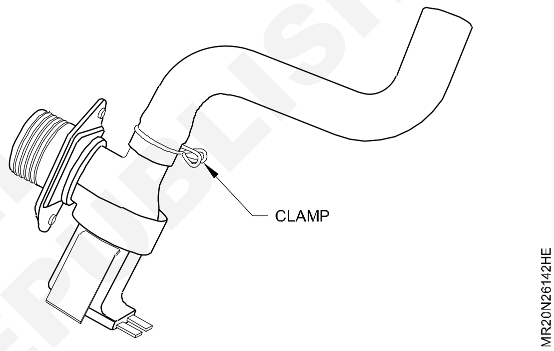
10 Lift the water inlet valve, release the inlet fill tube from the molded retainer and remove them from the ice maker. (Fig 13)

Fig 13



11 Remove the clamp from the inlet fill tube and remove the tube from the water inlet valve. (Fig 14)

Fig 14



Reassembly notes

- When you reconnect the inlet fill tube to the water inlet valve, be sure to position it as shown in the photo above.
- When you reinstall the water inlet valve and intlet fill tube in the ice maker, be sure to fit the tube inside the molded retainer, as shown at the top of the page.

d Remove the evaporator thermistor

Electrical shock hazard disconnect power before servicing. Replace all parts and panels before operating. Failure to do so can result in death or electrical shock.

1 Unplug ice maker or disconnect power.

2 Turn off the water supply to the ice maker.

3 Move the ice maker to gain access to the rear of the unit.

4 Disconnect the drain outlet hose from the ice maker.

5 Disconnect the water inlet line from the ice maker.

6 Open the ice maker door.

7 Remove the ice from the storage bin.

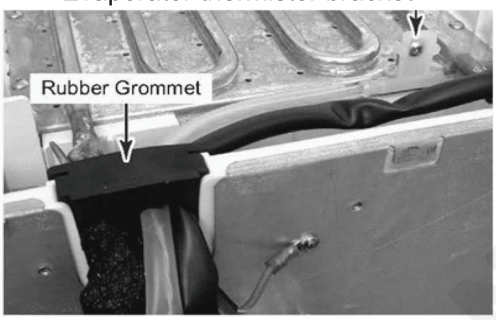
8 Remove the top cover.

Important: You will need to install and rebound a new evaporator thermistor if the old thermistor is loose, or is removed from the evaporator. Make sure that you have the new thermistor available prior to removing the old one. The correct sealant is provided with the new thermistor. The ice maker will not operate properly if the wrong sealant is used. Do not use silicon sealant; it will insulate the thermistor, affecting its operation.

9 Remove the screw from the evaporator thermistor mounting bracket, and break the bracket loose from the evaporator.

10 Remove the rubber grommet and remove the evaporator thermistor wires from the grommet. (Fig 15)

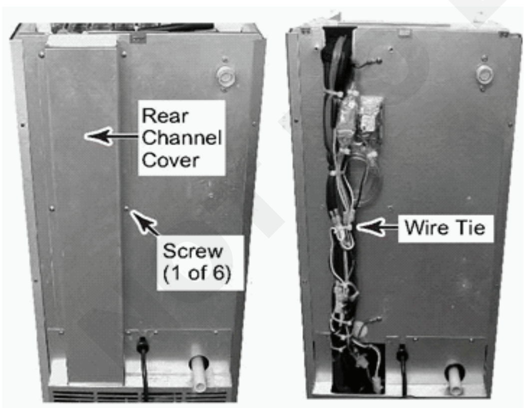
Fig 15



11 Remove the six screws from the rear channel cover and remove the cover from the ice maker.

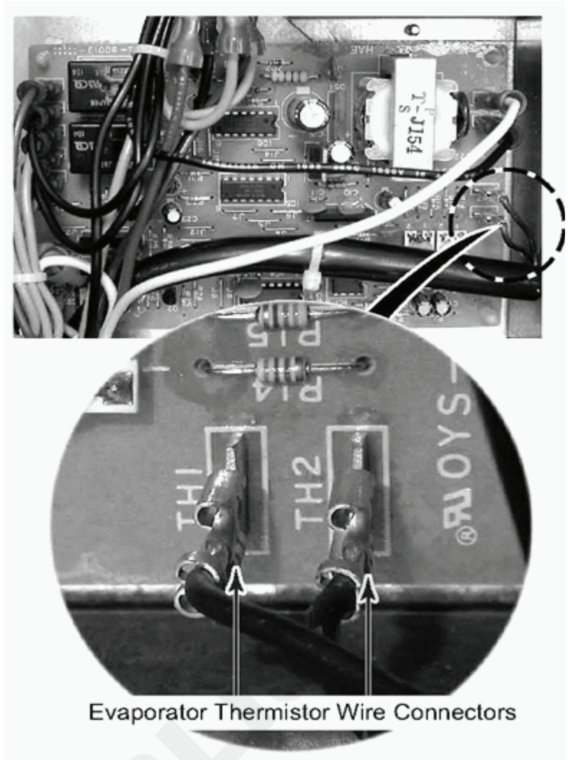
12 Cut the wire ties from the evaporator thermistor wire down to the control board. (Fig 16)

Fig 16



13 Disconnect the two evaporator thermistor wire connectors from the electronic control board terminals TH1 and TH2 and remove the evaporator thermistor. (Fig 17)

Fig 17



e Remove the bin thermostat

1 Unplug ice maker or disconnect power.

2 Turn off the water supply to the ice maker.

3 Move the ice maker to gain access to the rear of the unit.

4 Disconnect the drain outlet hose from the ice maker.

5 Disconnect the water inlet line from the ice maker.

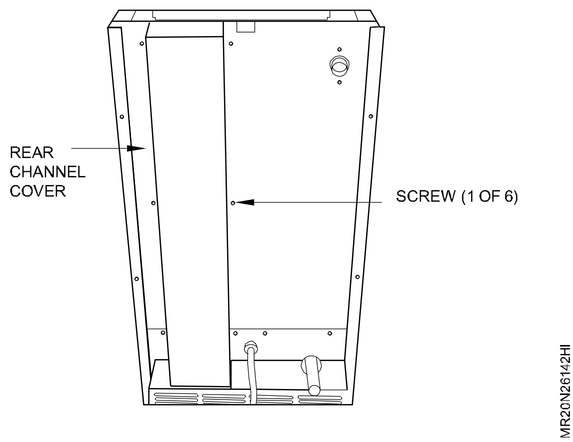
6 Open the ice maker door.

7 Remove the ice from the storage bin.

8 Remove the top cover.

9 Remove the six screws from the rear channel cover and remove the cover from the ice maker. (Fig 18)

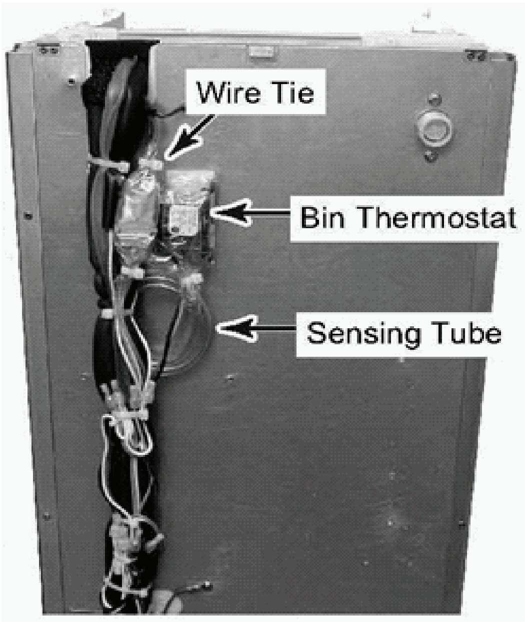
Fig 18



10 Remove the two screws from the bin thermostat bracket and remove the thermostat.

11 Cut the wire tie from around plastic bag and bin thermostat wires and remove the bag. (Fig 19)

Fig 19



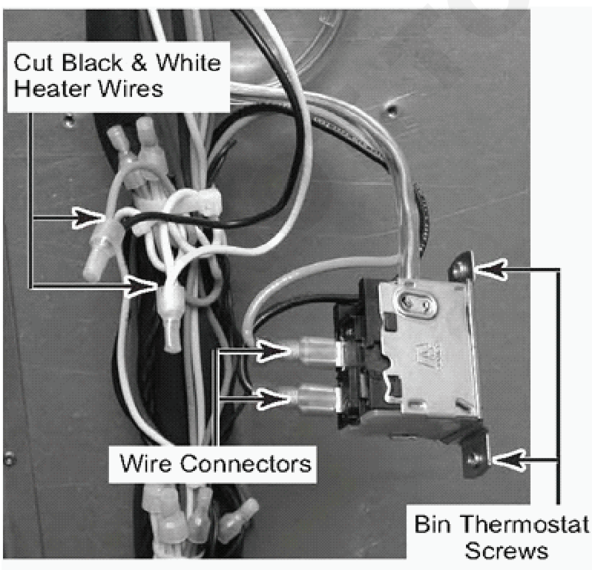
12 Disconnect the two wires from the bin thermostat terminals.

13 Cut the black and white heater wires from the harness.

Important : When reconnecting the wires to the harness, make sure that you position the open end of the wire connectors facing down to prevent moisture from becoming trapped. (Fig 20)

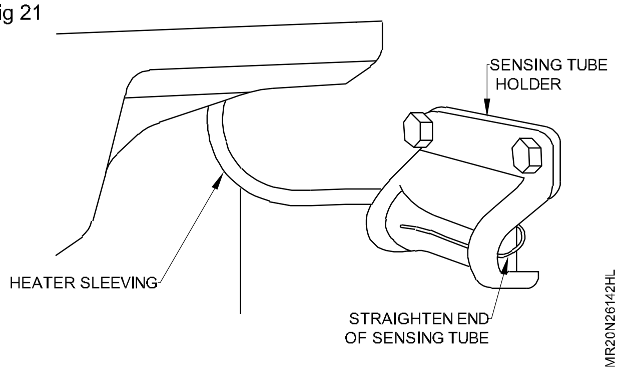
Note : Before you remove the bin thermostat sensing tube in the next step, note the way it is routed.

Fig 20



14 From inside the ice maker, straighten the end of the sensing tube, and pull it out of the holder. (Fig 21)

Fig 21



15 Pull the sensing tube and heater out of the rear of the unit, and remove the bin thermostat.

Reassembly Note : when you reinstall the sensing tube and heater from the new bin thermostat, make sure that you keep the sleeving at the same location inside the ice maker as the old sensing tube and heater.

f Remove the hot gas valve and solenoid

1 Unplug ice maker or disconnect power.

2 Turn off the water supply to the ice maker.

3 Move the ice maker to gain access to the rear of the unit.

4 Disconnect the drain outlet hose from the ice maker.

5 Disconnect the water inlet line from the ice maker.

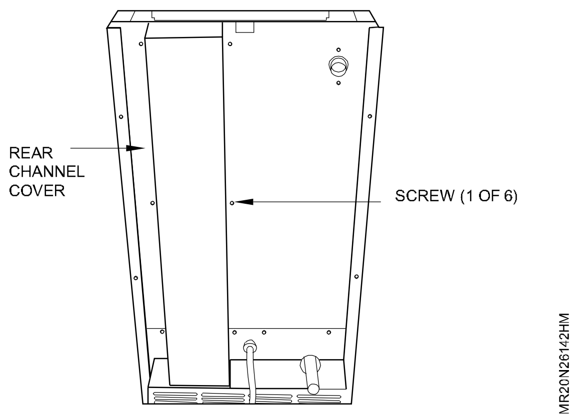
6 Open the ice maker door.

7 Remove the ice from the storage bin.

8 Remove the top cover.

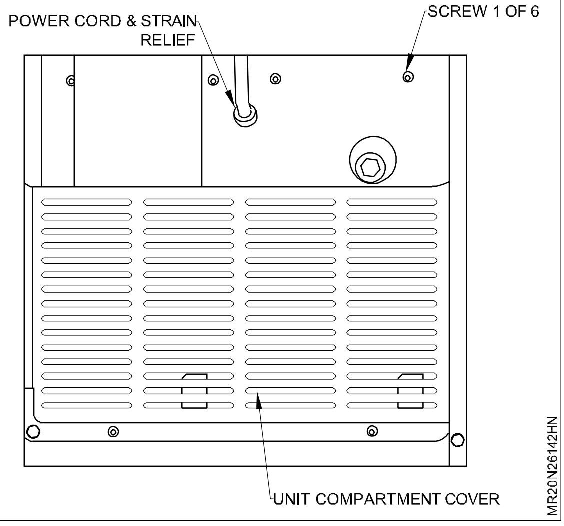
9 Remove the six screws from the rear channel cover and remove the cover from the ice maker. (Fig 22)

Fig 22



10 Remove the six screws from the unit compartment cover, remove the cover and pull the power cord and strain relief out of the u-channel. (Fig 23)

Fig 23



11 Remove the hot gas valve solenoid. (Fig 24)

Fig 24

a Disconnect the solenoid 2-wire connector from the harness. Cut any wire ties from around the solenoid wires.

b Remove the 7mm hex-head screw from the solenoid and lift the solenoid off the hot gas valve. (Fig 25)

12 Remove the hot gas valve.

a Remove the hot gas valve solenoid (see step 11 for the procedure).

b Shield the tubing insulation.

c Access the sealed system and discharge the refrigerant into an approved recovery system.

d Unbraze the hot gas valve from the sealed system (see the photo in the left column for the joints to braze). (Fig 26)

Fig 25

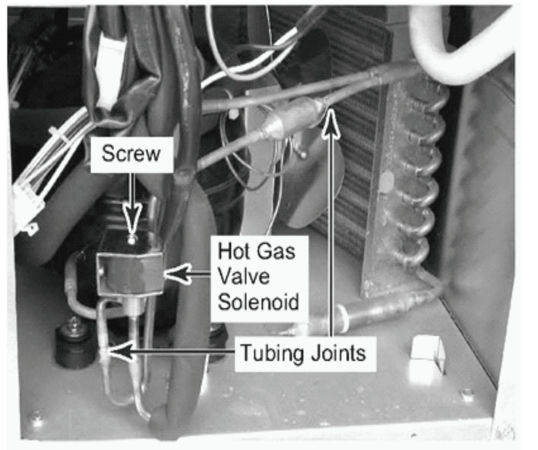
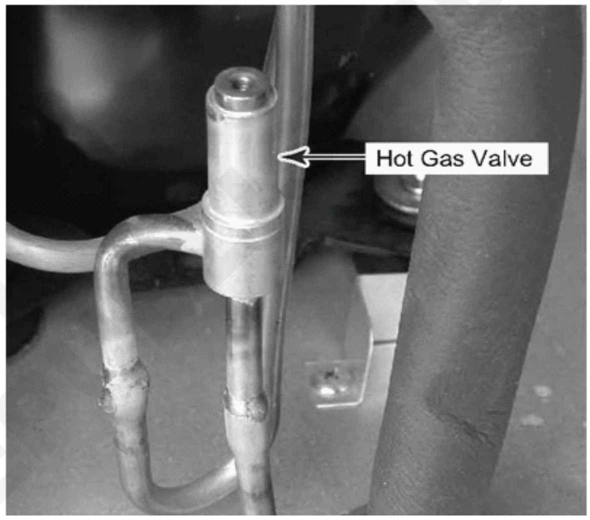


Fig 26



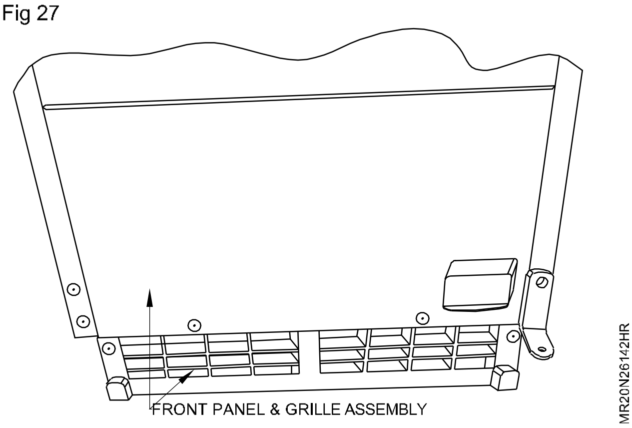
Reassembly Note : When installing the new hot gas valve, use a generous amount of thermal heat trap paste between the valve and tubing joints to protect the valve when brazing.

g Remove the master switch, recirculation pump motor capacitor and electronic control board.

1 Unplug ice maker or disconnect power.

2 Remove the screws from the lower front panel and grille assembly and remove the assembly. (Fig 27)

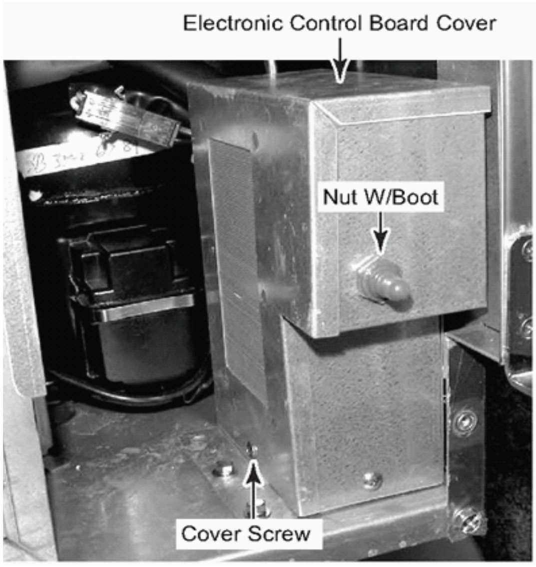
Fig 27



3 Remove the screw from the electronic control board cover and remove the cover (see the photo at the top of the next column).

4 To remove the master switch: (Fig 28)

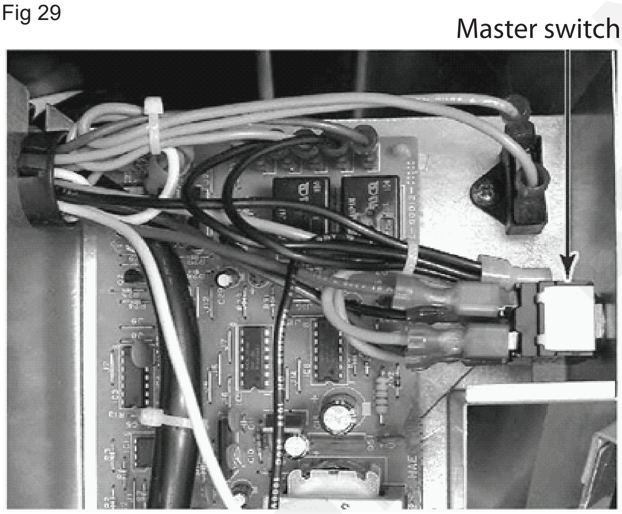
Fig 28



a Remove the hex nut w/boot from the master switch.

b Disconnect the five wires from the master switch terminals and remove the switch from the enclosure. (Fig 29)

Fig 29



5 To remove the recirculation pump motor capacitor:

a Disconnect the two wire connectors from the capacitor terminals.

b Remove the mounting screw from the capacitor and remove the capacitor from the enclosure. (Fig 30)

6 To remove the electronic control board:

a Disconnect the wire connectors from the electronic control board terminals.

b Squeeze the locking tab on each stand-off while you pull the board off the standoffs. (Fig 31)

Fig 30

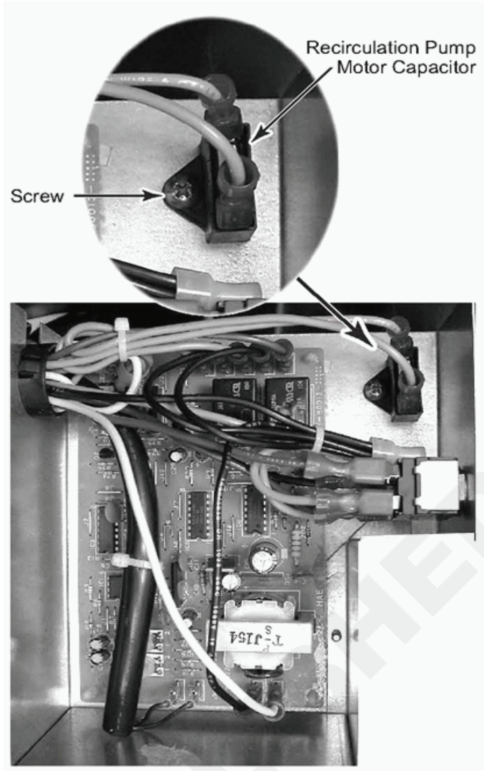
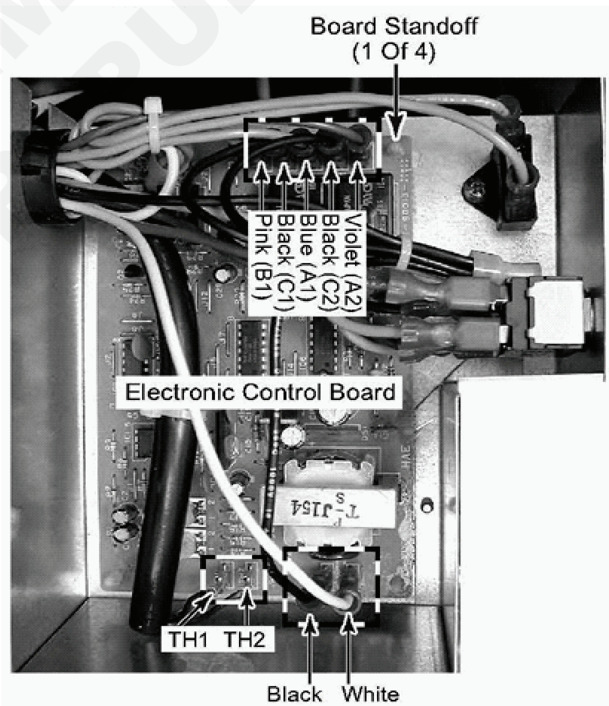


Fig 31



h) Remove the condenser fan motor.

1 Unplug ice maker or disconnect power.

2 Remove the screws from the lower front panel and grille assembly and remove the assembly. (Fig 32)

3 Remove the two 8mm hex head bolts from the condenser fan motor bracket. (Fig 33)

4 Cut the wire tie, disconnect the 2-wire condenser fan motor connector, and remove the fan motor. (Fig 34)

Fig 32

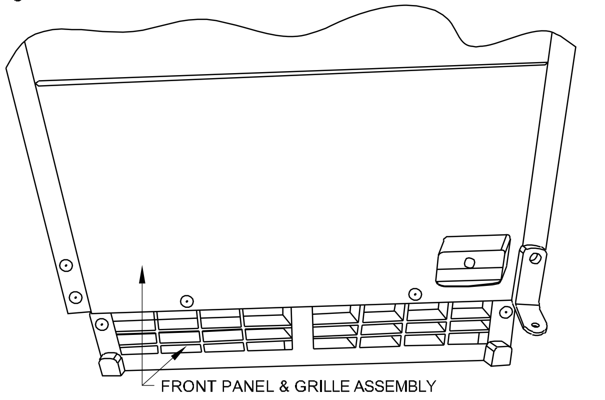
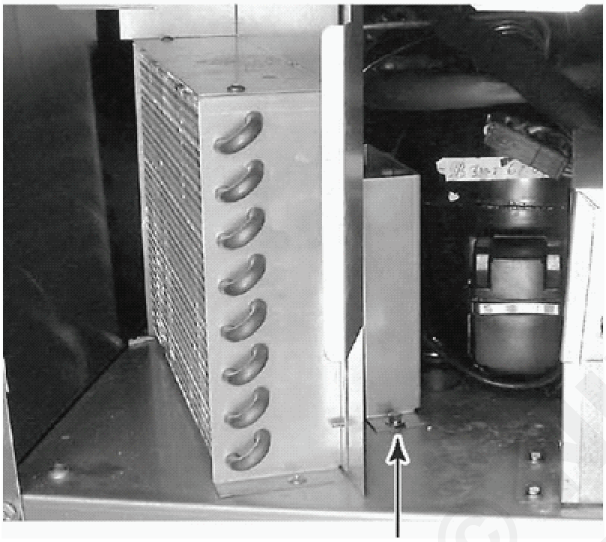
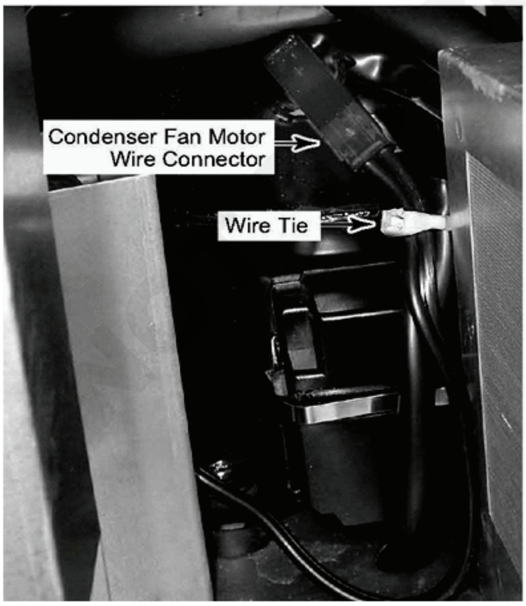


Fig 33



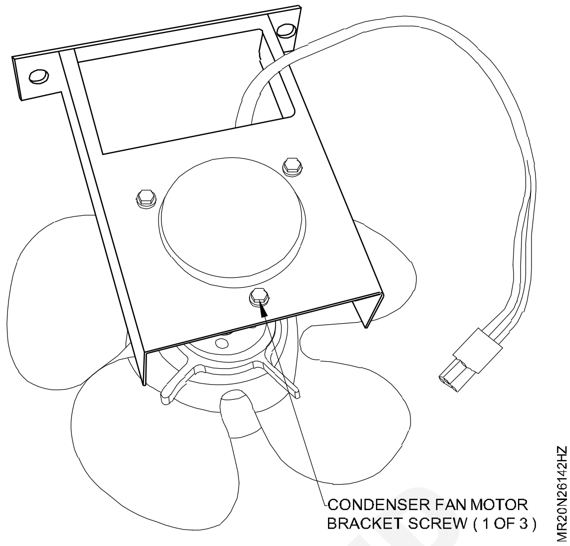
Condenser fan motor bracket bolts (1 of 2)

Fig 34



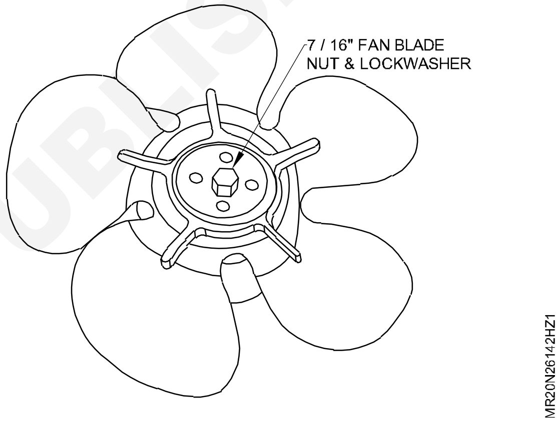
5 Remove the three 1/4" hex-head screws from the condenser fan motor and remove the motor from the bracket. (Fig 35)

Fig 35



6 Remove the 7/16" nut and lock washer from the condenser fan motor shaft and remove the fan blade from the motor. (Fig 36)

Fig 36



i) Removing the condenser

1 Unplug ice maker or disconnect power.

2 Turn off the water supply to the ice maker.

3 Move the ice maker to gain access to the rear of the unit.

4 Disconnect the drain outlet hose from the ice maker.

5 Disconnect the water inlet line from the ice maker.

6 Open the ice maker door.

7 Remove the ice from the storage bin.

8 Remove the screws from the lower front panel and grille assembly and remove the assembly. (Fig 37)

9 Remove the two screws from the condenser flanges.

10 Remove the two screws from the top condenser bracket. (Fig 38)

11 Remove the six screws from the unit compartment cover, remove the cover, and pull the power cord and strain relief out of the u-channel. (Fig 39)

Fig 37

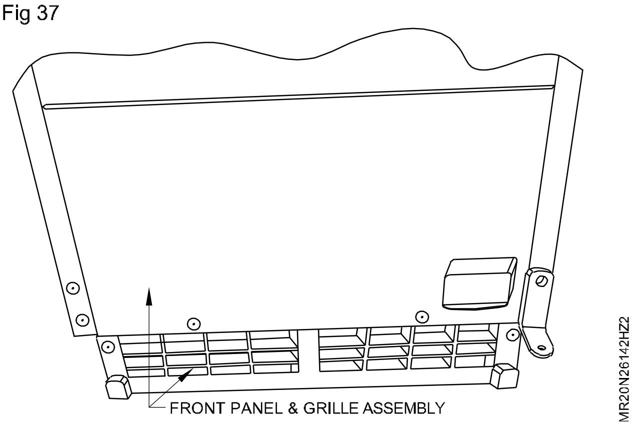


Fig 38

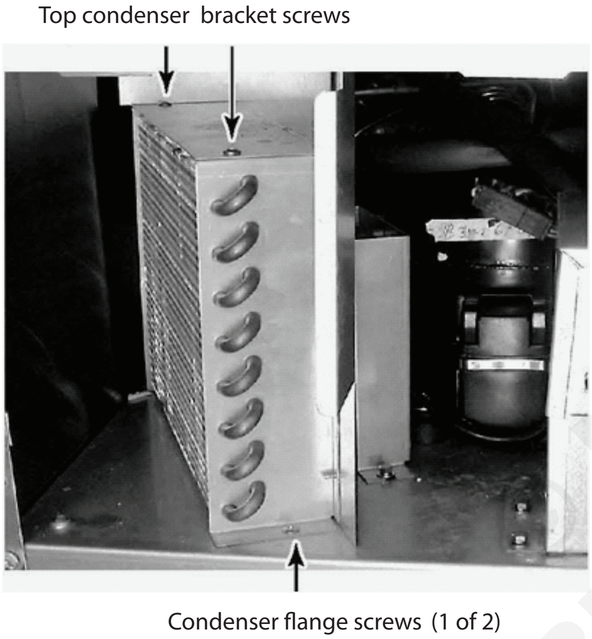
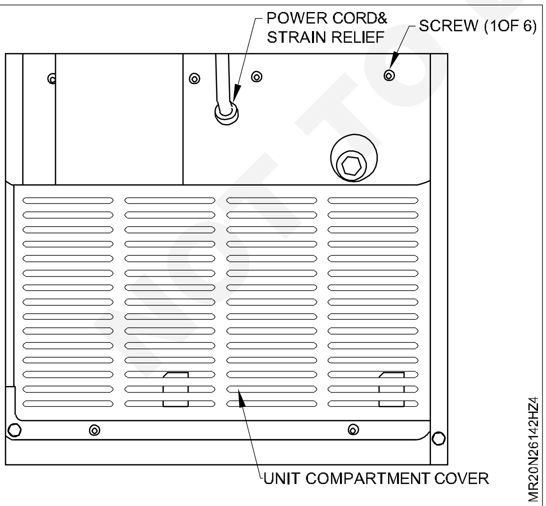


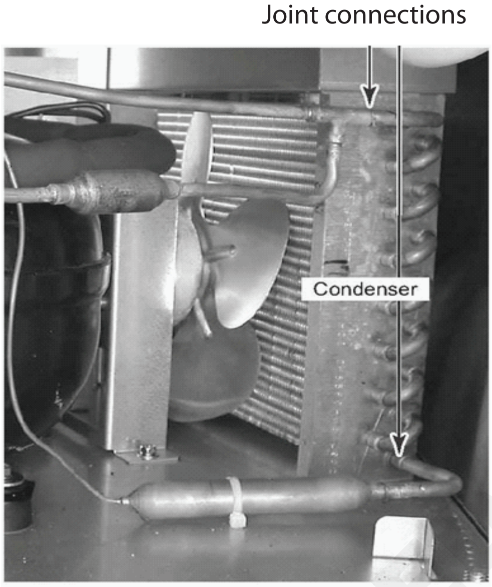
Fig 39



12 Access the sealed system and discharge the refrigerant into an approved recovery system.

13 Unbraze the two condenser joints from the sealed system a to remove the condenser. (Fig 40)

Fig 40



(j) Remove the compressor

1 Unplug ice maker door disconnect power.

2 Turn off the water supply to the ice maker.

3 Move the ice maker to gain access to the rear of the unit.

4 Disconnect the drain outlet hose from the ice maker.

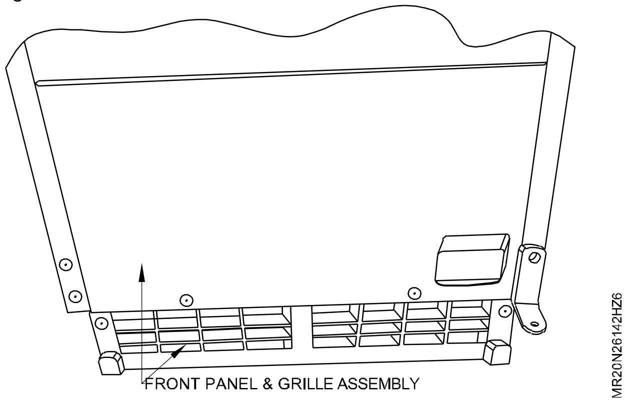
5 Disconnect the water inlet line from the ice maker.

6 Open the ice maker door.

7 Remove the ice from the storage bin.

8 Remove the screws from the lower front panel and grille assembly and remove the assembly. (Fig 41)

Fig 41



9 Remove the six screws from the unit compartment cover, remove the cover and pull the power cord and strain relief out of the u-channel. (Fig 42)

10 Push in on the front sides of the terminal cover clip and unhook it from the compressor slots, then remove the terminal cover. (Fig 43)

11 Remove the wire connectors from the relay and the overload protector.

12 Pull the relay and the overload protector from the compressor pins. (Fig 44)

Fig 42

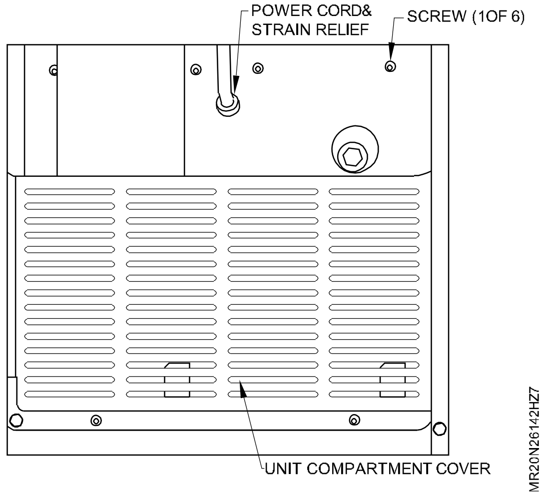


Fig 43

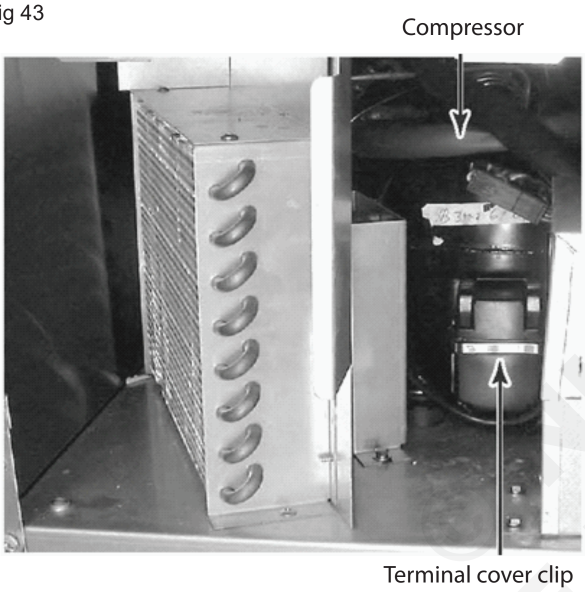
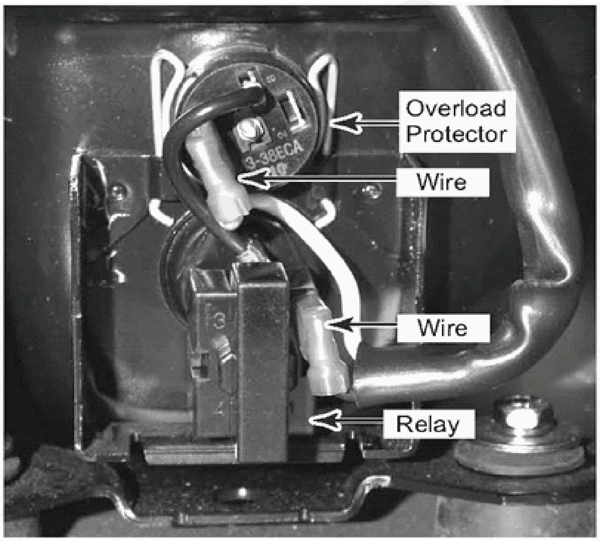


Fig 44



13 Access the sealed system and discharge the refrigerant into an approved recovery system.

14 Cut the suction and discharge lines.

15 Cut the filter/drier (see the photo at the top of the next column) from the system (do not use a torch to remove the filter/drier). (Fig 45 & Fig 46)

Fig 45

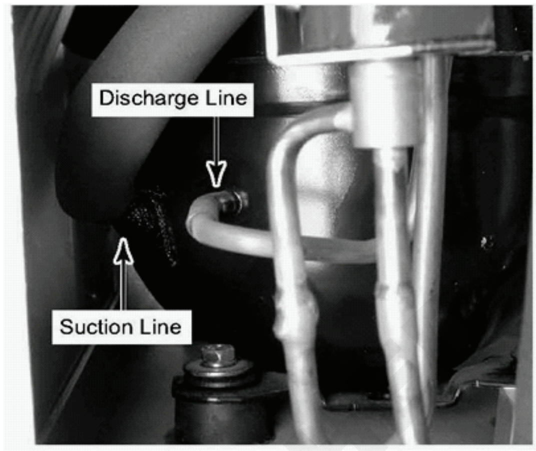
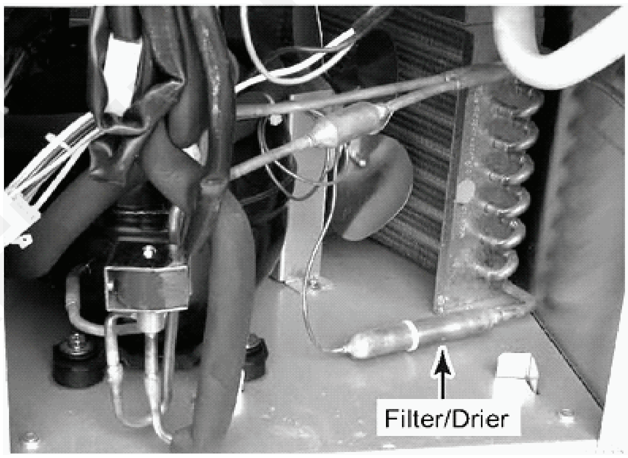


Fig 46



16 Remove the four compressor mounting screws from the rubber isolators and remove the compressor from the unit. (Fig 47)

Fig 47

Service ice cube container or mould

1 Remove the ice cube container from the machine.

2 Splash fresh forced water inside of the ice cube container or mould.

3 Prepare very dilute caustic soda solution.

4 Apply the solution throught out the mould.

5 Allow 30 minutes as it is.

6 Wash the ice cube container with fresh forced water atleast 5 times.

7 Dry the ice cube container with pure air and then ambient temperature.

8 Fix the ice cube tray into the machine.

Service the condenser

1 Take out the condenser from the machine (Refer TASK 1 - Removing condenser)

2 Straight all the fins of the fin and tube type condenser by a fin compressor.

3 Prepare caustic soda solution.

4 Pour the solution throughout the gap between fins and tubes.

5 Allow 30 minutes to stay as it is.

6 Wash the condenser with forced water atleast 5 to 6 times.

7 Dry the condenser fins and tubes with fresh air and allow to kept it in ambient condition for 30 minutes.

8 Assemble the condenser into the system.

Before servicing the condensor it is essential to seat the end of condensor tubes with a plastic seal to prevent entrance of contaminants and moisture inside the tubes.

Assemble the parts

1 Before assembling the parts, check individually all the parts to ensure its good condition.

2 Fix the evaporator into the ice cube maker and braze its inlet and outlet lines with refrigeration system and tighten it with four screws.

3 Fix the evaporator thermistor.

4 Fix the condensor, compressor, expansion device into the system by joining with copper tubes.

5 Fix the water inlet and outlet lines properly.

6 Fix the water inlet valve, water recirculation pump, bin thermostat, not gas valve and solenoid in appropriate places and connect them electrically with control unit (PCB).

7 Fix the master switch, recirculation pump, motor capacitor and electronic control board.

8 Fix the condenser fan with motor.

9 Fix the OLP and relay with the compressor.

Carryout pressure test

1 Arrange dry nitrogen with 2 stage regulator nearer to the machine.

2 Connect a hand shut off valve and high pressure gauge with process line of the compressor.

3 Connect the dry nitrogen cylinder with regulator to the hand shut off valve.

4 Plug the filter drier process tube.

5 Slowly open the nitrogen gas & carefully read the reading.

6 Stop the nitrogen when the system reached sufficient pressure.

7 Observe the pressure gauge continuously during one hour and ensure there is no leak in the system.

Identify different parts, controls and accessories used in ice candy plant

Objectives: At the end of this exercise you shall be able to
- **identify the parts and controls of the ice cream storage and candy plants.**

Requirements

Tools/Instruments

- Charging hose and HP, LP gauge - 1 Set.
- Screw driver - 1 No.
- Combination plier - 1 No.
- Trainees kit - 1 No.
- Double ended spanner - 1 Set.
- Test lamp (100W) - 1 No.
- Multimeter - 1 No.
- Ammeter (0-10A) - 1 No.
- Thermometer (-5 to 50°C) - 1 No.

Equipment/Machines

- Ice candy plant - 1 No.

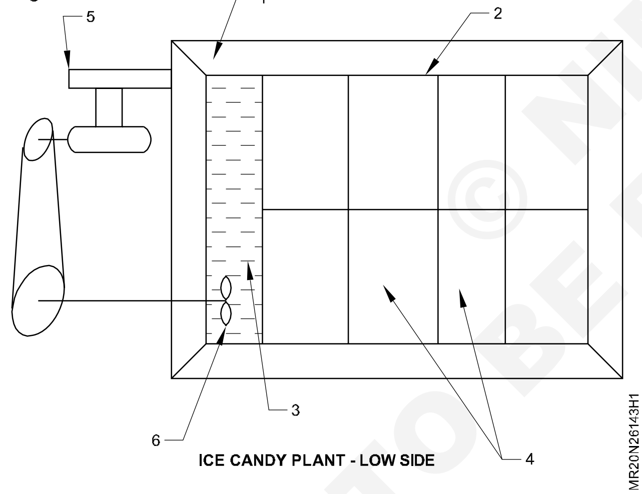
Materials

- Cotton waste - as reqd.

PROCEDURE

TASK 1 : **Identify the parts of Ice candy plant** (Fig 1)

Fig 1



1 Take the 'unit' to the work spot.

2 Make sure the unit is not connected with electrical supply.

3 Notice the whole unit physically.

4 Identify the top portion/first half of unit and open the lid/top door.

5 Identify the parts as per the letters and record the observation in the record sheet.

6 Close the top door.

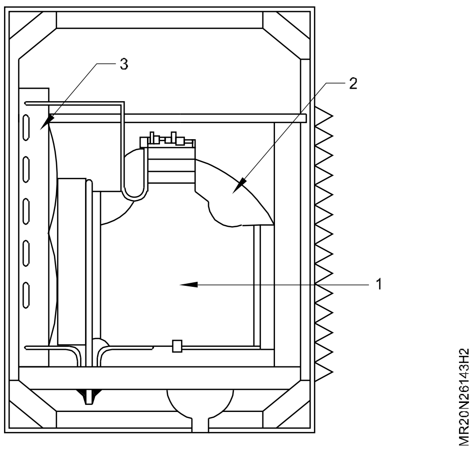
7 Identify the second half of unit at bottom. (Fig 2)

8 Remove the Grill/Inspection door by unscrewing the screws on the corners.

9 Identify the refrigeration components as labelled and observe the parts details.

10 Refix the Grill/Inspection door to its original position and tighten the screws using the screw driver.

Fig 2



— — — — — — — —

Record sheet

1 Name of the appliance: 'Ice candy plant'

Table 1

Identified parts

ID.No.	Fig. No.	Part name	Function/Type/Specification
1 2 3 4 5	1		
6 1 2 3	2		

Prepare brine solution, function of agitator and temperature maintained in brine

Objectives: At the end of this exercise you shall be able to
- **use hydrometer and find specific gravity**
- **check the density of brine/glycol solution**
- **add the chemical into the solution, and maintain brine temperature.**

Requirements

Tools/Instruments

• Hydrometer	- 1 No.
• Ball pein hammer 500g	- 1 No.
• Thermometer Digital/stem glass type (-50 to +10°C range)	- 1 No.
• Measuring tape (3 mts)	- 1 No.
• Measuring jar (3 lts)	- 1 No.
• Weighing balance (5 kg)	- 1 No.

Materials

• Goggles & Hand gloves	- 1 Pair.
• Pure & clean water	- as regq.
• Sodium chloride	- as reqd.
• Calcium chloride	- as reqd.
• Ethylene glycol	- as reqd.
• Propylene glycol	- 1 No.
• Indirect cooling system	- 1 No.

PROCEDURE

TASK 1 : **Use hydrometer and find specific gravity**

1 Take the unit to the work spot or the comfortable place.

2 Make sure the electrical power supply is disconnected.

3 Unscrew and remove the grille of condensing unit, identify the brine drain port. Remove cap and some quantity (2 lts) of brine in a measuring jar as a sample.

— — — — — — — —

TASK 2 : **Check the density of brine**

1 Put the hydrometer in the sample brine solution carefully and slowly.

2 Identify how much depth the hydrometer gone into the solution. Take the reading value, where the brine surface meets on the body of hydrometer.

3 Measure the temperature of brine sample using the thermometer and note down the value.

4 Access the quantity of salt to be added in the existing brine solution, using the brine properties table. (Refer trade theory) with the readings of specific gravity and temperature.

Example: If the hydrometer shows the value 1,2 at this point its concentration is 20%. But if we need the specific gravity 1.25 with concentration is 25%. Then we require 5% more concentration.

5 Assess the quantity of brine used/filled in the brine tank.

This can be calculated through either by measuring total quantity of brine accommodation volume (m^3) in the tank.

Example : If tank size is 1m x 0.35m x 0.3m depth, the volume is 0.105 m^3 which is equal to the weight of water at this volume is 105 kg. (Density of water is 1000 kg/m^3)

6 Calculate the quantity of salt to be added. **Example:** 5% of 105 kg is 5.25 kg.

— — — — — — — —

TASK 3 : **Add the chemical**

1 Make ready the quantity (5.25 kg) of 'salt' using the weighing machine.

2 Crush the salt into pieces to facilities mix well with the existing solution using hammer.

3 Add the crushed salt into the solution slowly step by step and carefully.

Wear goggles and hand gloves.

4 Connect the unit to the power supply and switch 'ON'.

5 Switch ON agitator motor only

6 Make sure the salt is mixes well with agitator.

If any difficult felt in this method of mixing the salt directly in the tank, make a separate concentrated mix outside then add the mix with existing solution.

7 Check the specific gravity of final brine mixture.

8 Make sure the brine solution in correct specific gravity.

9 Switch 'OFF' the unit.

10 Fillup the record sheet.

Record Sheet

Date:

Name of the appliance: Ice candy plant/ice cream storage plant

Name of the solution: ....

Sl. No.	Work status	Specific gravity	Temperature °C (from tables) % wt	Concentration	Remarks
1	Before adding chemical				
2	After adding chemical				

Quantity of salt crushed: .... kg.

Trainee **Instructor**

— — — — — — — — —

TASK 4 : **Retrofit ice candy plant**

Check the recovery machine initially

1 Check the label on the recovery machine, which refrigerant it was used with last time.

2 Check, if this is different to the refrigerant (R-12) to be recovered take the recovery unit to a well ventilated area (outside)

3 Open the suction and discharge valves to release as much refrigerant from the machine as possible

4 Connect a gauge manifold to the suction and discharge valves of the machine.

5 Remove both the gauges on the manifold and close the parts with dummy plugs (Refer Fig 1)

6 Connect a double stage vacuum pump to the common connection of the gauge manifold.

7 Check the vaccum pump doesn't have micron gauge, fix that gauge in between the manifold and the vacuum pump with the connecting hose.

8 Disconnect the duel pressure cut out switches, pressure line and put dummy plug, hence the bellows inside the cutout switch may get damage while the unit become under high vacuum.

9 Switch 'on' the vacuum machine and pull vacuum on the recovery machine of approximately 200 microns.

10 Close the valves (inlet and outlet) of the recovery machine, stop the vacuum pump and disconnect the gauge manifold.

11 Fit a compound gauge to the recovery machines suction inlet valve, and open the valve to suction pipe, open the discharge shut off valve also.

12 Switch on the main supply to recovery unit

13 Check the suction pressure gauge, if the compressor is in good condition, it should quickly pull down to a vacuum.

14 Check that the condenser fan is working.

15 Close the inlet and outlet valve and stop the recovery machine

16 Now the recovery unit is ready for recovery process. (Do not leave the compressor running for more than about 10 seconds during this self vacuum process)

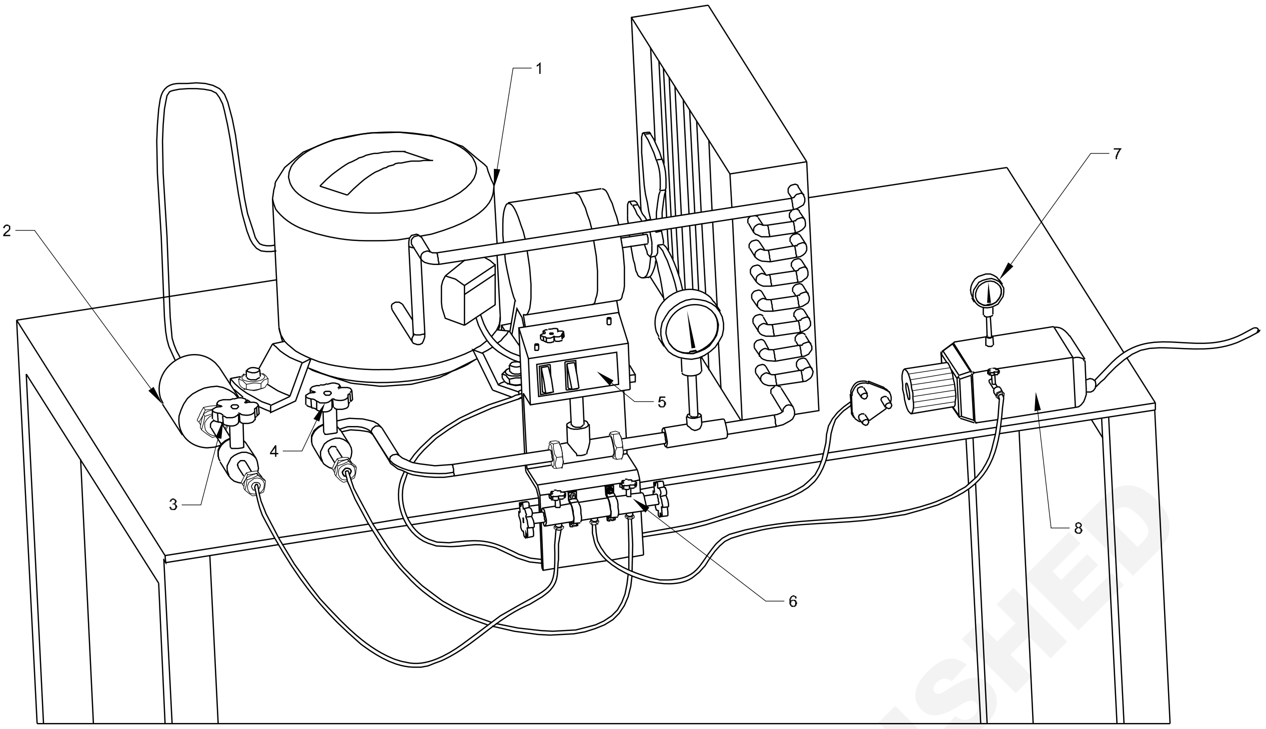
Recover CFC from the ice candy plant.

1 Connect the flexible (Charging) hose to the gauge port at suction service valve of the compressor

2 Connect the other end to the inlet of the recovery machine.

3 Connect the recovery machine outlet to storage cylinder (R-12) (Note the initial weight of the cylinder)

Fig 1



VACCUMISING THE RECOVERY MACHINE THROUGH GAUGE MANIFOLD

4 Open the suction service valve and recovery machines inlet and outlet valve purge the lines slightly and tighten the flare nut joints.

5 Start the recovery machine and recover the R-12 refrigerant from the plant to the cylinder.

6 Monitor the weight of the cylinder to ensure that it is not overfilled

7 After recovery completes close the suction service valve, recovery units inlet and outlet valves then cylinder valve.

8 Check and note the final weight of the cylinder and find the quantity of R-12 refrigerant recovered from the plant.

9 Remove all the charging hose connections, recovery machine put a label, the date and which gas was recovered

10 Take and keep the storage cylinder in the safe place.

Exchange the new components suitable for R134a

1 Disconnect the old compressor base bolts and flare nut joint of the suction and discharge lines, remove, label and keep it

2 Remove the air-cooled condenser, drier and expansion valves also

3 Seal the refrigerant line's ends till you connect new components.

4 Fix a new suitable compressor, condenser, after adjusting the base mountings.

5 Connect the molecular sieve type drier and suitable expansion valves on refrigerant lines.

6 Check if any where the refrigerant lines are to be changed or modified and correct those lines.

7 Tighten all the flare nut joints properly (Ensure all replacement components and pipe lines are clean and remain sealed till you fit into the refrigeration unit.

Flush out and vacuumize the plant

1 Connect the dry nitrogen cylinder to suction service valve's gauge port.

2 Regulate the dry nitrogen pressure to approximately 10 kgs/cm^2 and charge in to system.

3 Open the condenser outlet flare joint and flush out the dry nitrogen

4 Again charge up to 10 kgs/cm^2 after tighten the condenser outlet.

5 Check all the lines and joints for leak with soap solution.

6 If there is no leak release the nitrogen pressure and keep slight positive pressure and tighten the flare nut

7 Disconnect the dry nitrogen cylinder and connect double stage vacuum pump.

8 Start the vacuum pump and pull vacuum maximum till 5 microns stop the vacuum pump and wait and see the vacuum pressure is raising (if there is any minute leak)

9 Close the suction service valve and remove the vacuum pump connections.

Charge R134a to the plant and check the performance

1 Bring the charging cylinder which has accurate weight (Quantity) of refrigerant 134-a to that particular plant.

2 Connect the cylinder to suction service valve's gauge port, open the cylinder valve and purge the line slightly then tighten the nut.

3 Keep the cylinder as valve side facing down on the stand for quick transfer

4 Open the suction service valve and let the liquid refrigerant charge in to the plant.

5 Charge the liquid charge should be always when the plant kept in idle condition only.

6 Feel the charging hose and the cylinder soon as the charging (transferring) is over close the suction service valve.

7 Close the cylinder valve and disconnect the charging hose take and keep it

8 Fix compound gauge at suction service valve and pressure gauge at discharge service valve, keep both the valves in back seat crack position.

9 After the idle pressure equalize in both the gauges start the plant with usual care.

10 After one hour check suction, discharge pressures, brine temperature, and ice cream cabinets temperatures and record. Observe if the plant running smooth and check the current taken.

11 Adjust the expansion valve according to your need for the cabinets temperature, after one hour check the readings again

12 Compare the performance of R134-a running plant with previously with R-12 readings.

Record sheet

Ice candy plant

Table 1

	Compressor	Condenser	Expansion valve	Filter drier	134a refrigerant
Model					
Type					
Capacity					
Other specifications (Quantity)					

Components changed according to R134a details

Table 2

Performance comparison

	Suction pressure	Discharge pressure	Brine temperature	Storage cabinet temperature (1)	Storage cabinet temperature (2)	Current taken
Previous R-12 plant						
Present R134a plant						

— — — — — — — —

Identify parts, accessories and controls of ice plant

Objectives: At the end of this exercise you shall be able to
- **identify the mechanical components**
- **identify the parts in ice removal system.**

Requirements

Tools/Instruments

- Charging hose and HP, LP gauge - 1 Set
- Screw driver - 1 No.
- Combination plier - 1 No.
- Trainees kit - 1 No.
- Double ended spanner - 1 Set.
- Test lamp (100W) - 1 No.
- Multimeter - 1 No.
- Ammeter - 1 No.
- Thermometer (-5 to 50°C) - 1 No.

Equipment/Machines

- Ice plant - 1 Set.

Materials

- Cotton waste - as reqd.

PROCEDURE

TASK 1 : **Identify the mechanical components (Fig 1)**

1 Inspect 'unit' at work spot.

2 Make sure the unit is not connected with electrical supply.

3 Notice the whole unit physically.

4 Identify the top portion/first half of unit and open the lid/top door.

5 Identify the parts as per the letters and record the observation in the record sheet.

6 Close the top door.

7 Identify the second half of unit at bottom.

8 Remove the Grill/Inspection door by unscrewing the screws on the corners.

9 Identify the refrigeration components as labelled and observe the parts details.

10 Refix the Grill/Inspection door to its original position and tighten the screws using the screw driver. (Fig 1)

— — — — — — — —

TASK 2 : **Identify the parts in ice removal system**

1 Open the top door/lid.

2 Check the ice lifting crane.

3 Check operating arrangement. (Fig 2)

— — — — — — — —

TASK 3 : **Identify the electrical components**

1 Refer Fig 3 and identify

a) Compressor motor starter.

b) Condenser water pump starter.

c) Interlocking controls like HP cut-out, LP cut-out and Oil pressure control.

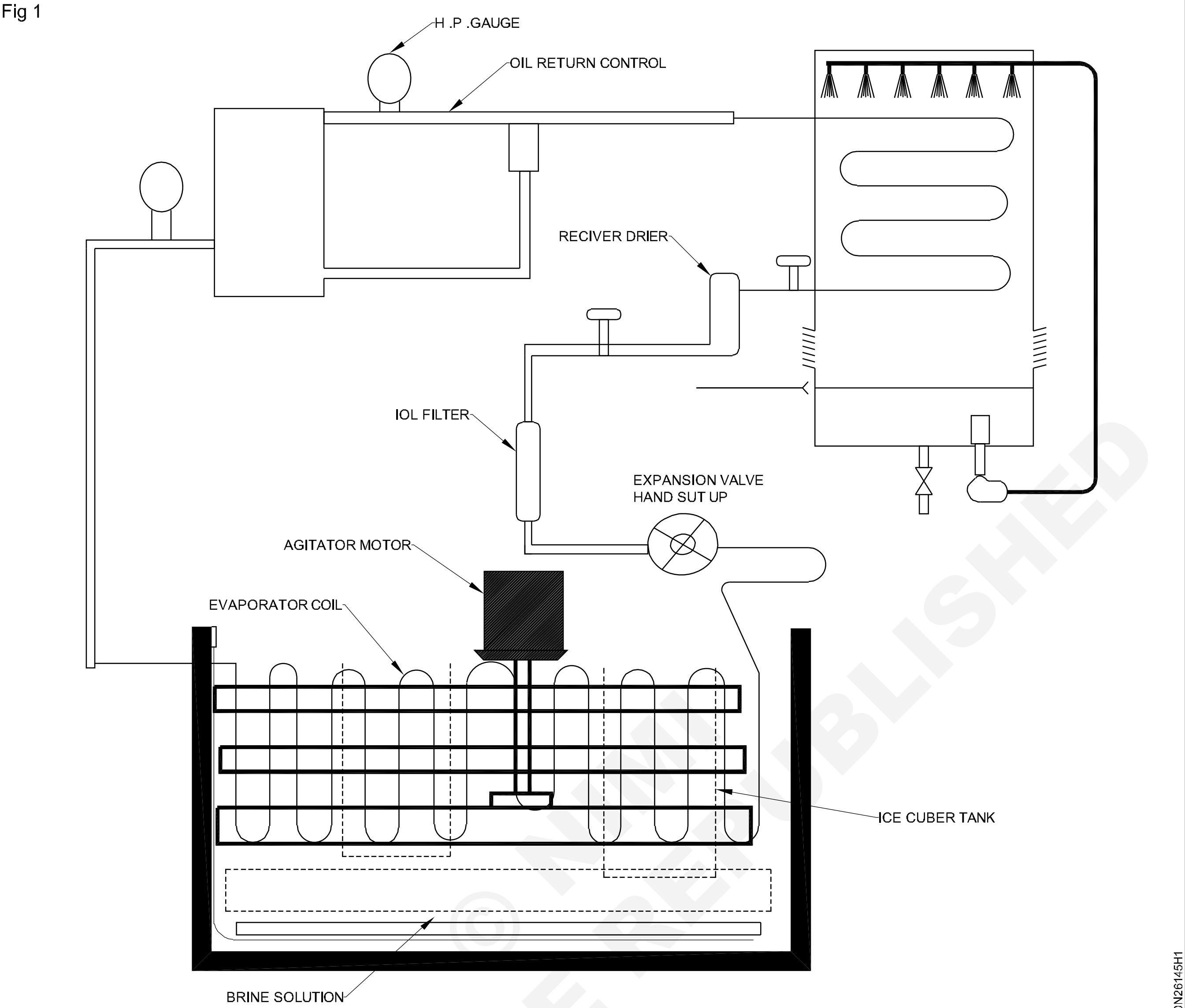
d) Agitator motor starter.

e) Compressor motor and its terminals.

f) Condenser water pump motor and its terminals.

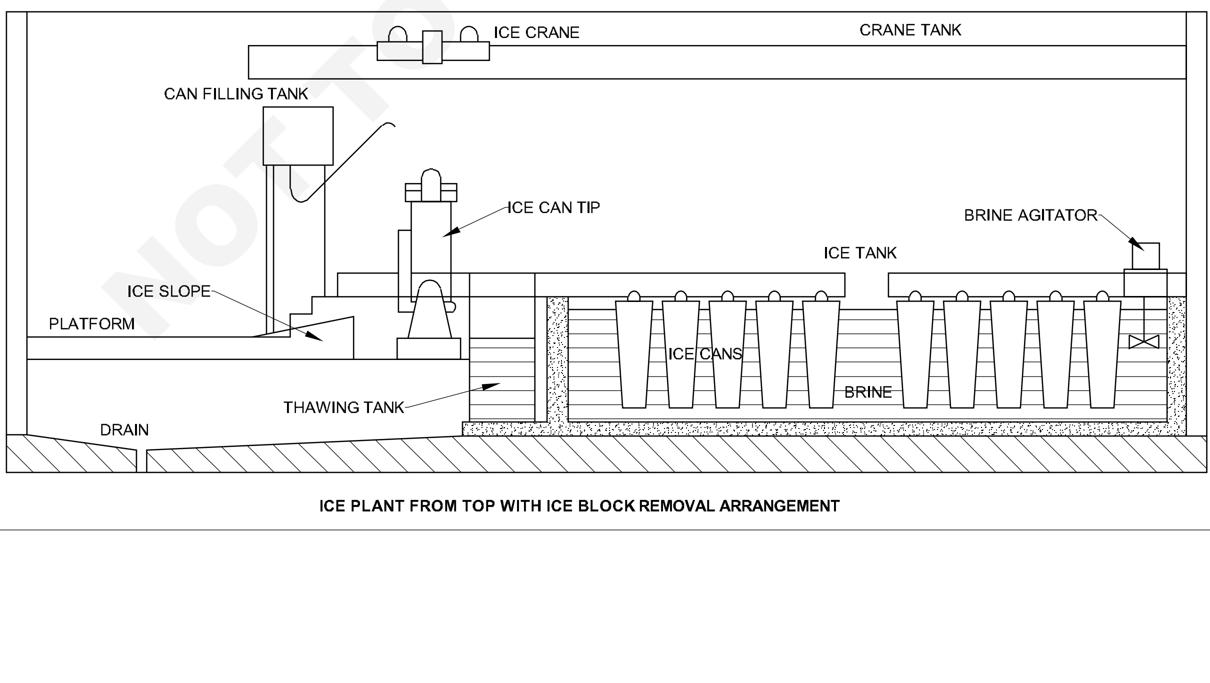
g) Agitator motor and its terminals.

Fig 1



REFRIGERATION CYCLE WITH COOLING TOWER

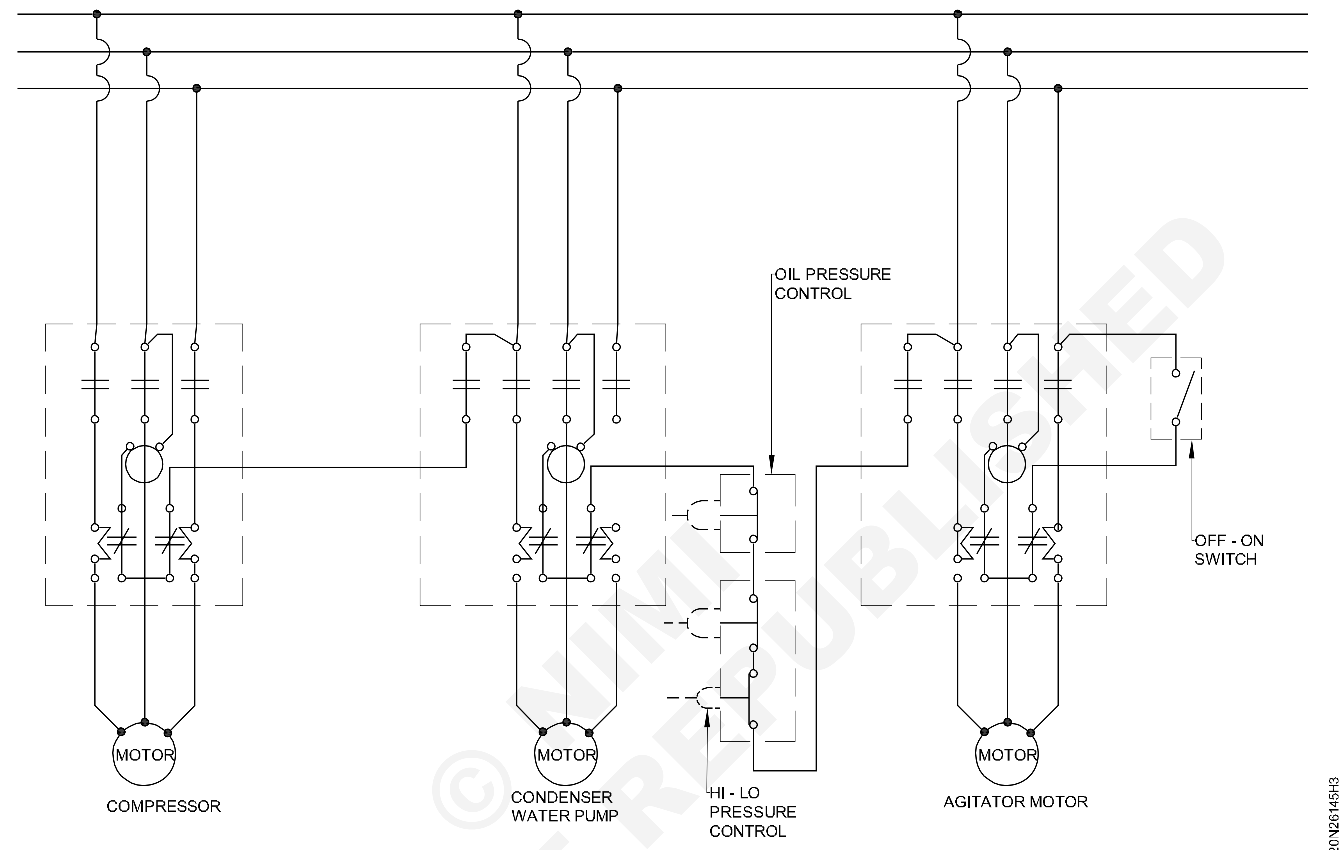
Fig 2



ICE PLANT FROM TOP WITH ICE BLOCK REMOVAL ARRANGEMENT

Sl. No.	Identified parts	Specification	Working codition (Yes/No)
1			
2			
3			

Fig 3



WIRING DIAGRAM OF ICE PLANT

Record sheet

1 Name of the appliance: 'Ice plant' - Mechanical Components

Table 1

Identified parts

ID.No	Fig. No	Part name	Function/Type/Specification
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			

1 **Name of the appliance : 'Ice plant' - Electrical Components**

Table 2

Identified parts

ID. No	Fig. No	Part name	Function/Type/Specification
1			
2			
3			
4			
5			
6			
7			
8			
9			

Maintain temperature in brine and check agitator

Objectives: At the end of this exercise you shall be able to
- **measure the temperature of brine solution**
- **check the agitator of the brine tank.**

TASK 1 : **M**easure **the temperature of brine solution**

1 Run the machine for one hour.

2 Lift the lid of the ice candy plant.

3 Insert remote bulb of the thermometer in to the brine solution

4 keep five minutes and note the temperature.

5 Repeat the process into the various corners of the brine tank and measure the brine temperature.

— — — — — — — —

TASK 2 : **Check the agitator of the brine tank.**

1 Start the ice candy plant.

2 Check the working of agitator motor.

3 Check the motion of brine solution.

4 Check the working of starter of agitator motor.

5 Check the voltage of agitator motor.

6 Check the RPM of agitator motor

7 Switch off the agitator motor and check the belt tension

8 Check the Pulley of a agitator motor and impeller..

— — — — — — — —

Check, Service and operate ice plant

Objectives: At the end of this exercise you shall be able to
- **check and test electric circuit and controls of ice plant**
- **check and service ice plant.**

Requirements

Tools/Instruments

• Double ended spanner	- 1 Set
• Test lamp for 3 phase (100W)	- 1 No.
• Multimeter	- 1 No.
• Tong tester	- 1 No.
• 3 Phase test board	- 1 No.
• Insulated combination pliers	- 2 Nos.
• Thermometer (-5 to 50°C)	- 1 No.
• Screw driver	- 1 No.
• Pressure gauge 0 to 30 kg/cm^2	- 1 No.
• Pressure gauge 0 to 10 kg/cm^2	- 2 Nos.
• Trainees kit	- 1 No.
• Spirit level	- 1 No.
• Thermometer	- 1 No.
• Test lamp	- 1 No.
• Tong tester (or) Volt and ammeter	- 1 No.
• Hammer	- 1 No.
• Allen key set	- 1 Set.
• Air blower	- 1 No.
• Double end spanner	- 1 Set.
• Ratchet wrench	- 1 No.
• Charging hose with gauge	- 1 No.
• R134a service cylinder	- 1 No.
• Fins cleaning comb	- 1 No.
• Hydrometer	- 1 No.

Equipment/Machines

• High pressure safety cut out	- 1 No.
• Safety valve	- 1 No.
• Oil pressure safety cut out	- 1 No.
• Nitrogen cylinder with 2 stage regulator	- 2 Sets.
• Open type (brine) ice plant	- 1 No.

Materials

• Charging line	- 2 Nos.
• Cotton waste	- as reqd.
• Rubber gloves	- as reqd.
• Rubber shoes	- as reqd.
• Insulation tape	- as reqd.
• Continuity tester	- 1 No.
• Cotton waste (or) clean cloth	- as reqd.
• Grease and oil	- as reqd.
• Insulation tape	- 1 Roll.
• 3 core wire 32/40 (2.5 Sq.mm)	- as reqd.
• Caustic soda	- as reqd.
• Kerosene oil	- as reqd.
• Soap and brush	- as reqd.
• Compressor oil (Lubricating oil)	- as reqd.
• Non corrosive paint and brush	- as reqd.

PROCEDURE

TASK 1 : **Check and test electric circuit and controls of ice plant**

I Check electrical controls

a 3 phase star-delta starter for compressor

1 Remove all the connections from the mains supply.

2 Remove all motor connections from the starter.

3 Take out the starter from the plant.

4 Check all the no-volt coils of contactors with multimeter.

b Check and service condenser fan motor (D O L)

1 Remove all the connections from the mains supply.

2 Remove all motor connections from the starter.

3 Take out the starter from the plant.

4 Check all the no-volt coils of contactor with multimeter.

c Interlocking controls like Thermostat, HP cut-out, LP cut-out and Oil pressure control

1 Thermostat

1 Check Temperature control (Thermostat).

2 Set thermostat knob to low cool.

3 Start the unit.

4 Take a glass of crystal ice(200 gms) and keep the thermal bulb inside the glass. The unit will trip immediately.

5 Switch off the package unit for 5 minutes to avoid immediate start.

6 Remove the thermal bulb and place it at evaporator air suction.

7 Close the evaporator compartment cover.

8 Adjust the thermostat knob to earlier position. (Fig 1)

2 Check high pressure safety cut out.

1 Refer Fig 2 and Identify the internal parts of a high pressure safety switch, record in Table-1of Record Sheet.

2 Keep nitrogen cylinder regulators in closed position by keeping the handle fully loose.

3 Open the nitrogen cylinder valve with the valve key.

4 Check the cylinder pressure on the dial in Gauge1.

5 Connect the charging hose to the pressure switch as shown in Fig 2.

6 Set the required pressure on the regulator gauge No.1 and on line pressure gauge. (Fig 3)

Fig 1

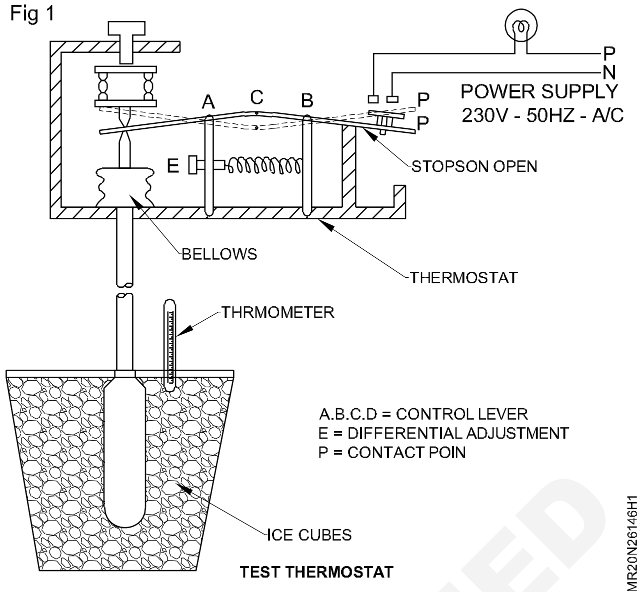
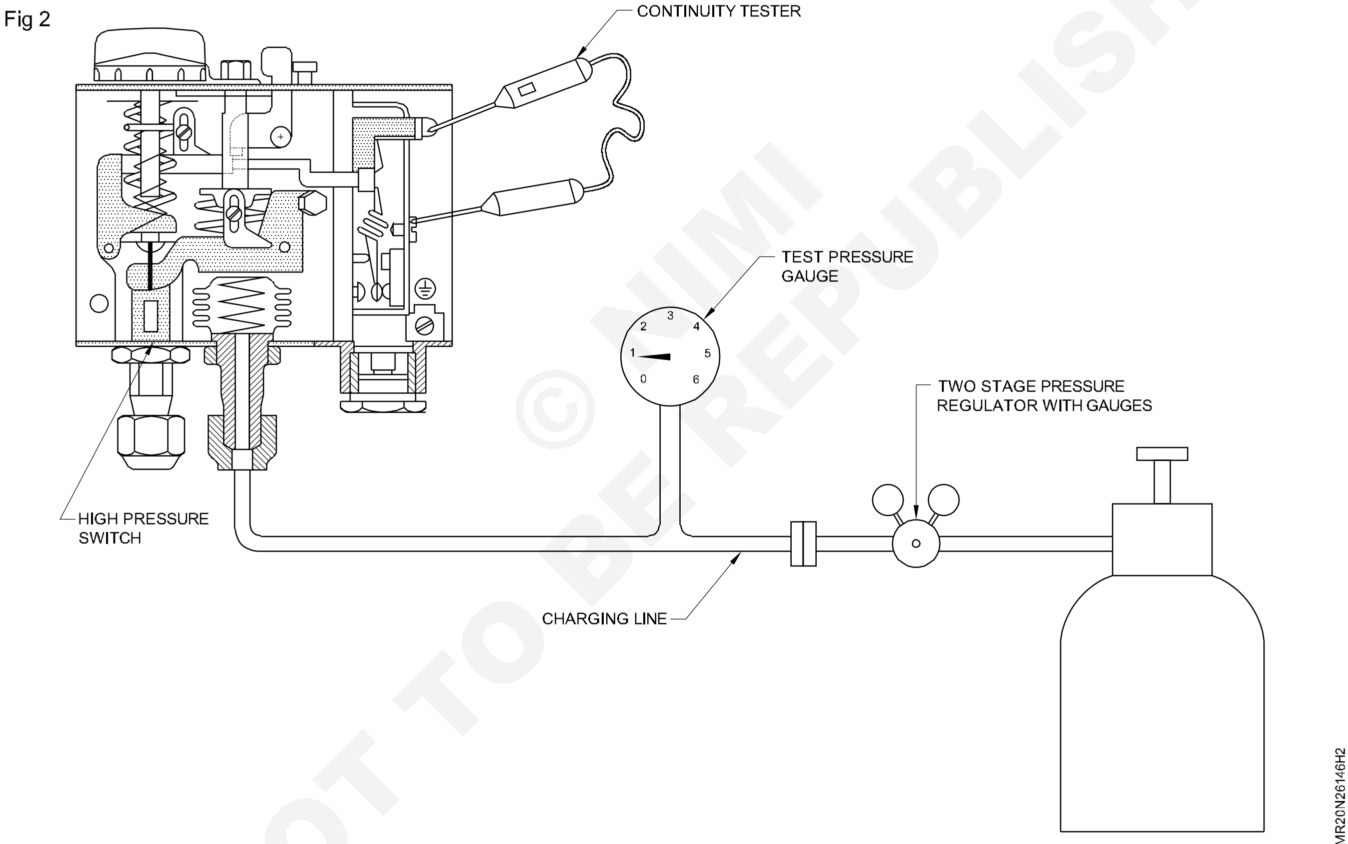


Fig 2



7 Watch the movement of the spring and place the battery operated continuity tester leads on the terminal across NO & NC terminals, the light should not glow. This indicates that the switch has cut out.

8 Reduce the nitrogen pressure by loosening the flare nut No.10 when the pressure drops to differential pressure. Place the continuity tester probes on the terminals the light will glow.

9 This indicates that the switch has reset. (Fig 4)

Example: The Freon 22 water cooled condenser, High pressure cut out at 16.0 kg/cm^2. The reset is 14.0kg/cm^2.

The differential is 2.0 kg/cm^2 2 Calibrate the switch and set the cut out pressure

3 Check oil pressure safety cut out

1 Connect one nitrogen cylinder to the oil pressure bellows (element) as illustrated in Fig 5.

Fig 3

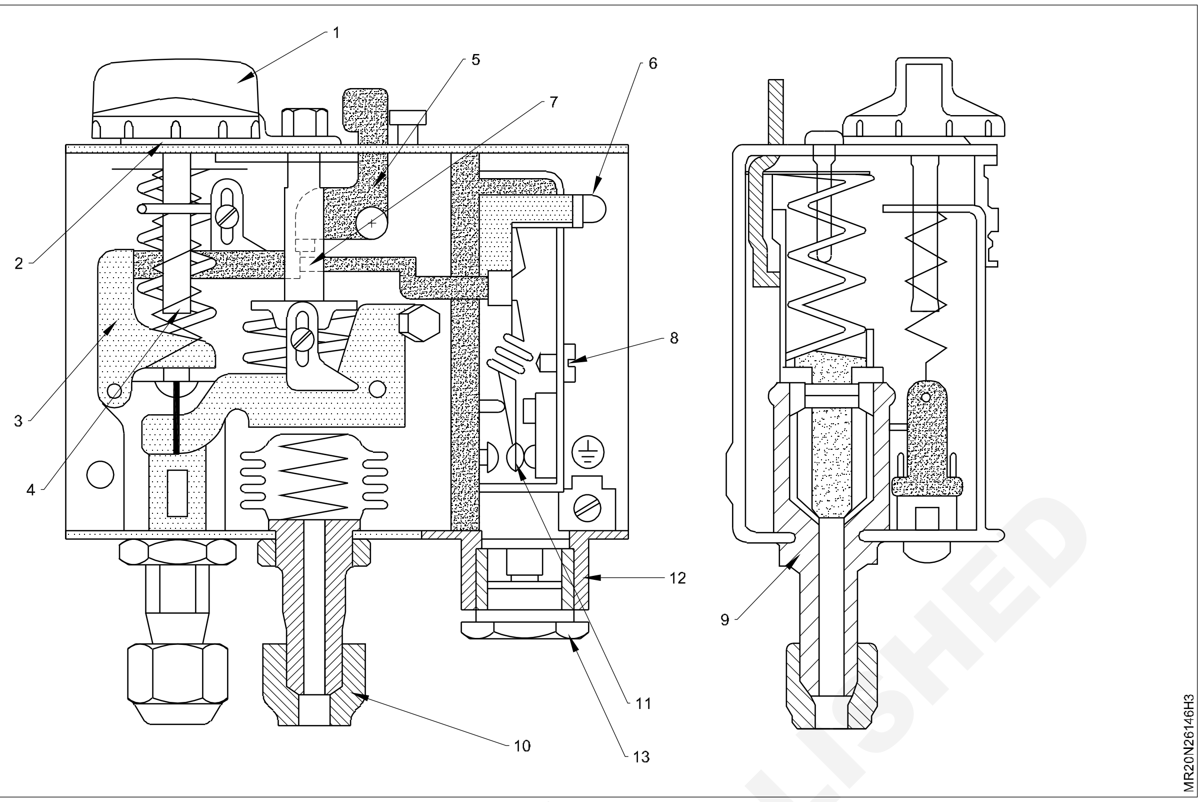
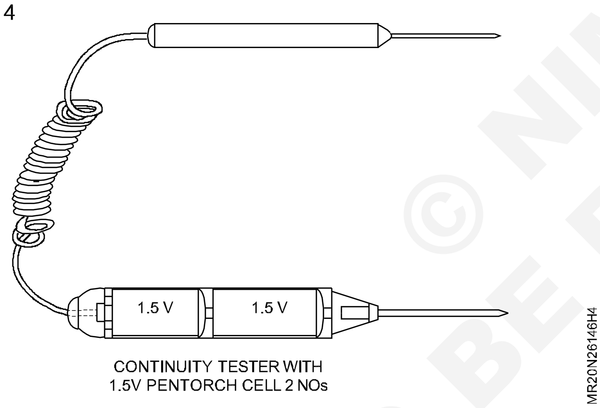


Fig 4



CONTINUITY TESTER WITH 1.5V PENTORCH CELL 2 NOs

2 Connect the one more nitrogen cylinder to the crankcase bellows.

3 Open both the cylinder valves and set the required crank case pressure on the charging line gauge. Set the required pressure on the oil pressure charging line gauge. The pressure can be adjusted by adjusting the regulators. Then set the required differential on the switch scale.

Example: If the operating oil is 3.0 kg/cm^2. The operating suction pressured is 2.0 kg. The switch is 2.0 kg. The switch should be set for 3.0 - 2.0 = 1.0 kg differential.

4 Place the continuity tester probe on the leads of the switch. When the oil pressure are set at mentioned above. The continuity test light should glow. This indicates that the switch is closed. Close the cylinder oil pressure charging cylinder, loosen the flare nut and drop the oil pressure to 2.0 kg. The contacts will open and the continuity tester light will not glow. This indicates that the switch is set OK. Refer Fig 5.

1 Isolate the switch from power and gas connection.

2 Remove the switch from location.

3 Connect to nitrogen cylinder with two stage regulator as shown in Fig 6.

4 Set the cut out pressure at 2.0 kg/cm^2 on switch cutout scale.

5 Open nitrogen cylinder by using the valve key.

6 And set the Nitrogen pressure at 2.0 kg/cm2 on the 2 stage pressure regulator gauge No.2.

7 Check the switch if it has cutout, by placing the continuity tester on the load.

8 The bulb in the continuity tester should not glow.

9 Set cut in pressure at 3.0 kg. in differential scale.

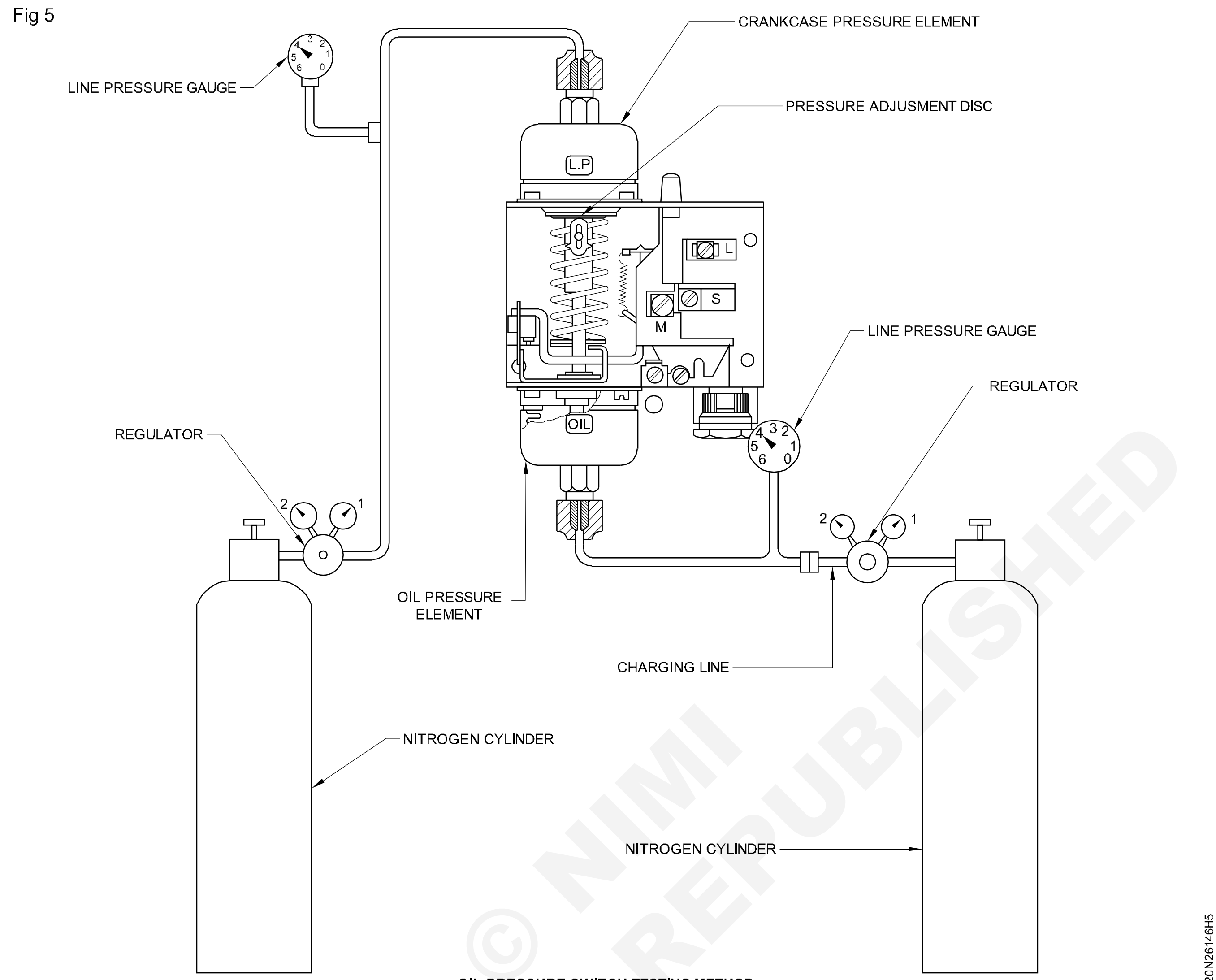
10 Increase the nitrogen pressure to 3.0 kg/cm^2 and place the continuity tester probes on the switch leads the light has to glow. This indicates that the switch contacts are closed.

11 Close nitrogen cylinder and disconnect the fittings from the switch.

12 Fix the switch lock plates and cover.

13 Keep switch ready for use.

Fig 5



OIL PRESSURE SWITCH TESTING METHOD

II Make wiring

1 After check all the electrical control and equipment place in position.

2 Connect all the components as per diagram. (Fig 7)

3 Energised the unit with power supply.

4 Check the working of all the components.

III Check performance

1 Switch on the plant.

2 Check the current and voltage during starting and running period on panel board.

3 Check the working of all starters .

4 Observe and record pressure at which L.P ,H.P and oil pressure are working.

5 Observe the temperature cut off of thermostat.

6 Record all the observation in record sheet.

Sl. No.	Name of the component	Reading previous	Reading present
1			
2			
3			

— — — — — — — —

Fig 6

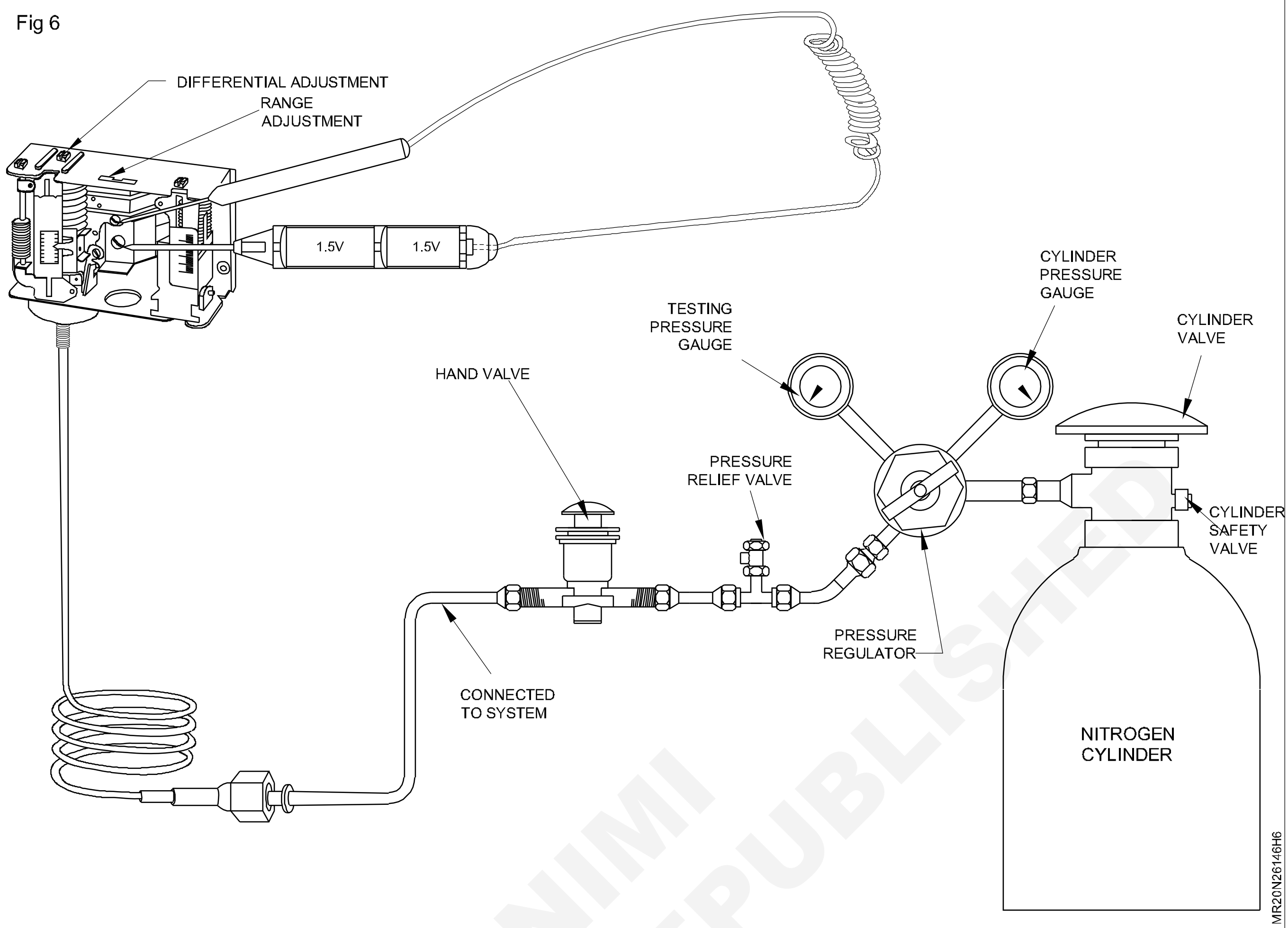
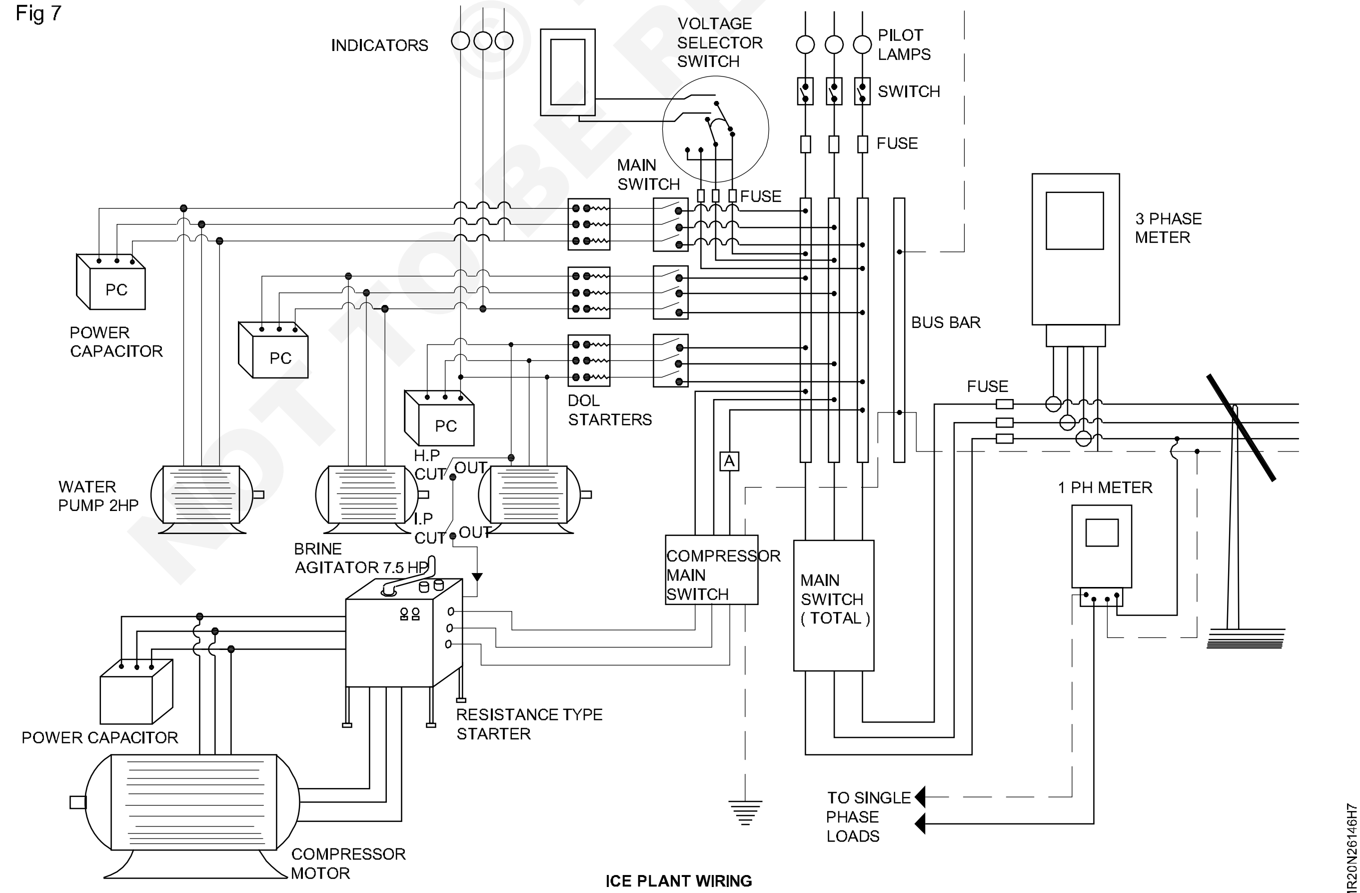


Fig 7



ICE PLANT WIRING

TASK 2 : **Check and service ice plant**

I Dismantle all the major components

1 Pump down the system and switch off the machine.

2 Unload the ice trays with ice if any remained in the machine.

3 Close the compressor service and liquid receiver valves.

4 Remove the condensing units cover and release the belt from compressor.

5 Detach all the pipe connections in the refrigeration system.

6 Loose all the nut and bolts of the condenser and take it out from the system.

7 Take out compressor, evaporator, hand expansion valve from the system.

8 Remove the agitator unit with pulley after detach the belts from motor and pulley.

9 Keep all the components in a safe place and take necessary steps for preventing air entering inside the components.

II Check evaporator insulated cabinet

1 Clean the internal surface of the cabinet with fresh water.

2 Apply dilute caustic soda solution on the surface.

3 Allow 20 minutes time to react with scales and impurities.

4 Wash the cabin again with forced water and repeat two to three times.

5 Check the surface of the insulated cabinet for its insulation.

III Service ice slab container

1 Clean the ice slab container with fresh water.

2 Apply diluted caustic soda on the surface and allow 20 minutes time.

3 Wash the container with forced water till full cleaning is obtained.

4 Check the surface thoroughly for its physical damage.

IV Clean, flush evaporator and condenser coils.

1 Wash both coils with fresh water.

2 Apply caustic soda solution through all the coil surfaces.

3 Allow 30 minutes to react with scales and impurities.

4 Wash the coils with forced water till full cleaning is obtained.

V Replace faulty parts

1 Check all the components of the dismantled system.

2 Replace necessary parts if necessary with a new one.

VI Assemble the components.

1 Check all the dismantled parts.

2 Fix the compressor, condenser, evaporator, hand expansion valve in to the system with suitable fixtures.

3 Connect the system with pipes.

4 Fix the agitator with motor and belt.

5 Place the ice trays in to the cabinet.

VII Carry out pressure test

1 Connect the dry nitrogen cylinder with two stage regulator to the suction service valve.

2 Keep both service valves in their middle seated position.

3 Slowly admit nitrogen by opening regulator valve.

4 Stop the nitrogen supply when the pressure gauges in the system shows a pressure of 500 psi.

5 Close suction service valve by front seated it.

6 Make thick soap solution and apply all the necessary joints.

7 Allow the system to hold the pressure up to one hour.

8 Observe the pressure gauge reading whether there is any drop in pressure.

Note : Do not run the plant when pressurised with nitrogen and release the nitrogen before performing the evacuation process.

— — — — — — — —

Identify parts, accessories, controls and operation of walk-in cooler/reach in cabinet

Objectives: At the end of this exercise you shall be able to
- **identify the electrical components**
- **identify the mechanical components.**
- **operate the walk in cooler/reach in cabinet/mini cold storage.**

Requirements

Tools/Instruments

- Trainees kit - 1 No.
- Hammer - 1 No.
- Allen key set - 1 Set.
- Air blower - 1 No.
- Double end spanner - 1 Set.

Equipment/Machines

- Walk in cooler - 1 No.

Materials

- Hand woollen gloves - 1 Set.
- Woollen rain coat - 1 No.
- Gum boots - 1 Set.
- Woollen cap - 1 No.

PROCEDURE

TASK 1 : **Identify and dismantle the electrical components**

1 Refer wiring diagram supplied by manufacturer and understand different electrical components of the system.

2 Switch of the machine.

3 Wear all the personal protective equipments.

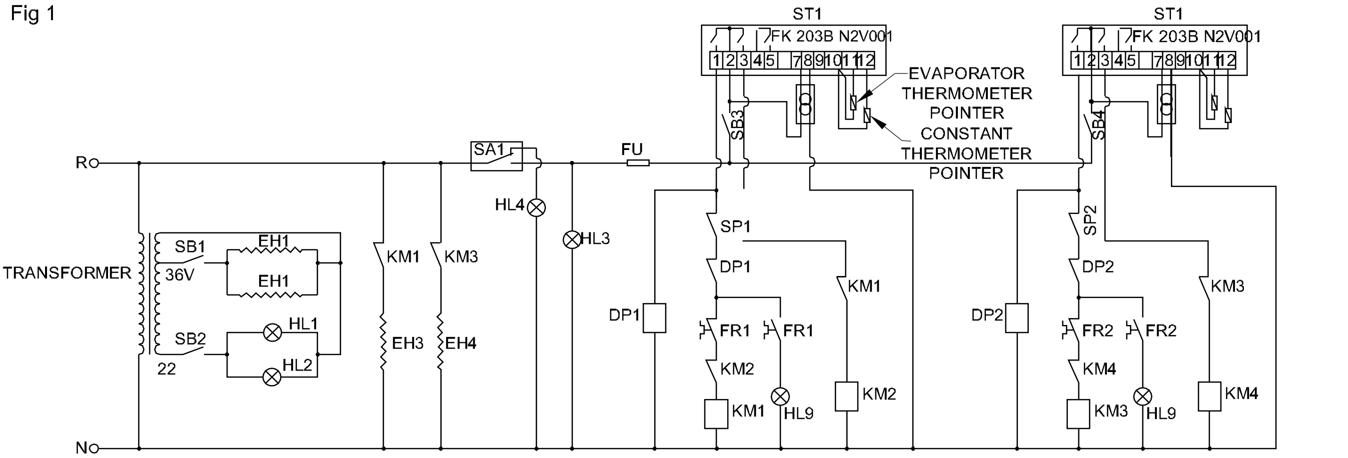
4 Disconnect the wires from each components and note down colour code of wires.

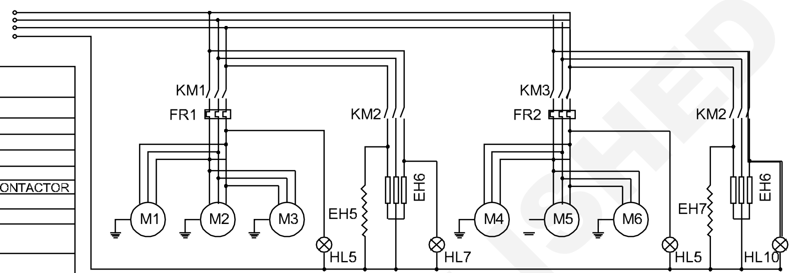
5 Take out each of the electrical components and fill up in the record sheet with Fig 1.

Record sheet Table No. 1 (Electrical components of walking cooler)

Sl. No.	Identified parts	Function	Location	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				

Fig 1





NO	SYMBOL	EQUIP	NO	SYMBOL	EQUIP
1	M1	1#CONDENSER FAN	17	SB1	DOOR / VENT HEATER SWITCH
2	M2	1#COMPRESSOR	18	SB2	DOOR LIGHT
3	M3	1#FAN	19	SB3	1#SERVICE SWITCH
4	M4	2#CONDENSER FAN	20	SB4	2#SERVICE SWITCH
5	M5	2#COMPRESSOR	21	KM1, KM3	COMPRESSOR CONTACTOR
6	M6	2#FAN	22	KM2, KM4	DEFROST/DRAIN PAN HEATER CONTACTOR
7	EH1	DOOR HEATER	23	ST1,ST2	THERMOSTAT
8	EH2	VENT HEATER	24	SP1, SP2	PRESSURE RELAY
9	EH3	1#COMPRESSOR CRANKCASE HEATER	25	DP1, DP2	COMPRESSOR PROTECTOR
10	EH4	2#COMPRESSOR CRANKCASE HEATER	26	FR, FR2	COMPRESSOR THERMAL RELAY
11	EH5	1#EVAPORATOR DRAIN PAN HEATWER	27	HL1, HL2	DOOR LIGHT
12	EH6	1#EVAPORATOR DEFROST HEATER	28	HL3	PROPER POWER SUPPLY LIGHT
13	EH7	2#EVAPORATOR DRAIN PAN HEATER	29	HL4	FAILURE POWER SUPPLY LIGHT
14	EH8	2#EVAPORATOR DEFROST HEATER	30	HL5, HL8	COMPRESSOR OPERATING LIGHT
15	SA1	PHASE LOSS MONITOR	31	HL6 HL9	COMPRESSOR MALFUNCTION LIGHT
16	FU	HEATER	32	HL7, HL10	DEFROSTING / DRAINING LIGHT

AIR - COOLED WALK - IN ELECTRICAL WIRING DIAGRAM FOR UNIT < 10HP

MR20N26147H1

TASK 2 : **identify and dismantle the mechanical component**

1 Switch off the machine.

2 Observe thoroughly the name plate provided by the manufacturers.

3 Refer Fig 1, identify all the mechanical parts and its location.

4 Record all the parts in the table 1 of record sheet and signed by instructor.

Fig 1

Record sheet Table No. 2 (Mechanical components of walk-in cooler)

Sl. No.	Identified parts	Function	Location	Remarks
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				

— — — — — — — —

TASK 3 : **Operate the walk in cooler/reach in cabinet/mini cold storage**

1 Switch on the main power supply of the machine

2 Start the compressor

3 Check the suction and discharge pressure.

4 Check the voltage and ampere drawn by the unit.

5 Check the temperature of cold room.

— — — — — — — —

Preventive maintenance, trouble shooting and servicing of components

Objectives: At the end of this exercise you shall be able to
- **identify the components in the electrical wiring diagram of walk in cooler/reach in cabinet**
- **make the wiring of walk in cooler and check the components**
- **common trouble shoot in electrical wiring.**

Requirements

Tools/Instruments

- Combination plier - 1 No.
- Tong tester - 1 No.
- Multimeter - 1 No.
- Test board suitable for 3 phase - 1 No.
- Screw driver - 1 No.
- Test lamp 3 phase - 1 No.
- Double end spanner - 1 Set.

Equipment/Machines

- Walk in cooler - 1 No.

Materials

- Insulation tap - 1 Roll.
- Hand gloves - 1 Pair.
- Safety shoes - 1 Pair.

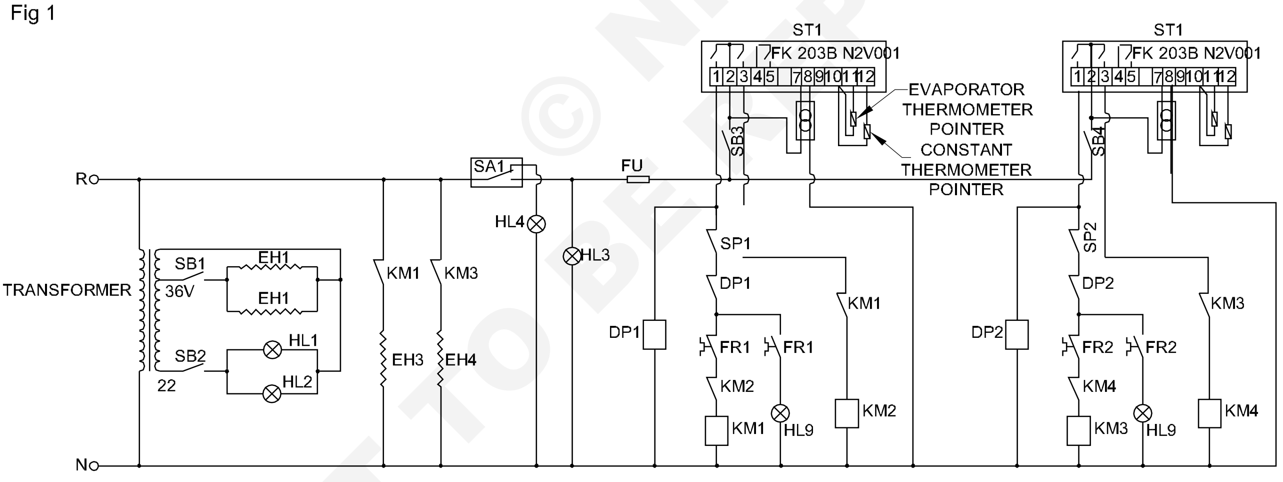
PROCEDURE

TASK 1 : **Identify the components in electrical wiring diagram of walk in cooler**

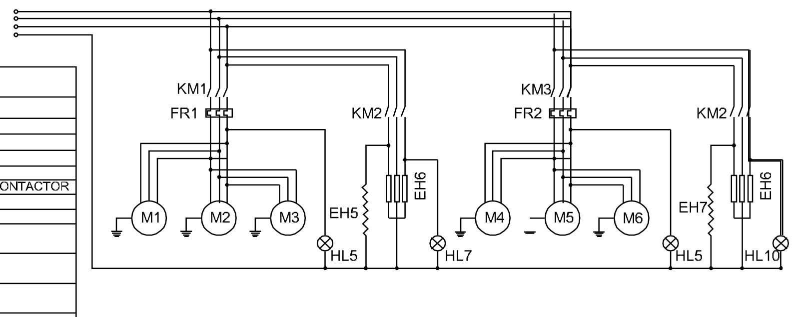
1 Switch off the machine.

2 Wear safety shoe and hand gloves.

Fig 1



NO	SYMBOL	EQUIP	NO	SYMBOL	EQUIP
1	M1	1#CONDENSER FAN	17	SB1	DOOR / VENT HEATER SWITCH
2	M2	1#COMPRESSOR	18	SB2	DOOR LIGHT
3	M3	1#FAN	19	SB3	1#SERVICE SWITCH
4	M4	2#CONDENSER FAN	20	SB4	2#SERVICE SWITCH
5	M5	2#COMPRESSOR	21	KM1, KM3	COMPRESSOR CONTACTOR
6	M6	2#FAN	22	KM2, KM4	DEFROST/DRAIN PAN HEATER CONTACTOR
7	EH1	DOOR HEATER	23	ST1,ST2	THERMOSTAT
8	EH2	VENT HEATER	24	SP1, SP2	PRESSURE RELAY
9	EH3	1#COMPRESSOR CRANKCASE HEATER	25	DP1, DP2	COMPRESSOR PROTECTOR
10	EH4	2#COMPRESSOR CRANKCASE HEATER	26	FR, FR2	COMPRESSOR THERMAL RELAY
11	EH5	1#EVAPORATOR DRAIN PAN HEATWER	27	HL1, HL2	DOOR LIGHT
12	EH6	1#EVAPORATOR DEFROST HEATER	28	HL3	PROPER POWER SUPPLY LIGHT
13	EH7	2#EVAPORATOR DRAIN PAN HEATER	29	HL4	FAILURE POWER SUPPLY LIGHT
14	EH8	2#EVAPORATOR DEFROST HEATER	30	HL5, HL8	COMPRESSOR OPERATING LIGHT
15	SA1	PHASE LOSS MONITOR	31	HL6 HL9	COMPRESSOR MALFUNCTION LIGHT
16	FU	HEATER	32	HL7, HL10	DEFROSTING / DRAINING LIGHT



AIR - COOLED WALK - IN ELECTRICAL WIRING DIAGRAM FOR UNIT < 10HP

MR20N26148H1

3 Refer the wiring diagram given in Fig 1 and identify different components.

4 Fill up the record sheet with identified parts and get it signed by your instructor.

Record Sheet

Sl. No.	Specification if any in name plate	Parts identified	Mode of connection	Connected in between	Colour code of wire
A B					

— — — — — — — —

TASK 2 : **Make the wiring of walk in cooler and check the components**

1 Check all the electrical components of wiring diagram with multimeter and test lamp.

2 Replace the worn out or damaged components.

3 Understand clearly the wiring diagram shown in Fig 1.

4 Perform electrical wiring according to the given wiring diagram (Fig 1)

5 Switch on the machine and check the working of the machine.

— — — — — — — —

TASK 3 : **Common trouble shoot in electrical wiring**

1 Refer the trouble shoot chart and do the trouble shoot activity.

2 Record the trouble shoot activities in the record sheet.

Hint to instructor : Only some sample problems/malfunctions are discussed in the sample trouble shoot chart. The instructor should simulate the trainees by giving more problems related with electrical wiring and instruct the trainees to analyse the causes with remedial measures for the new problems.

Trouble Shooting Chart

Malfunction	Possible Cause	Solution
Power is on, but control board does not display	1 Phase loss or fuse blown 2 Power phase open or transformer 3 Control board failure	1 Check wiring for breaks & replace fuse. 2 Check transformer output voltage (12V) shorted 3 Replace cold storage room control board.
Control board displays, but compressor does not run	1 Compressor relay tripped 2 Hi-Lo pressure safety switch down 3 Defective contactor or coil 4 Cold room temperature is lower than operation set point. 5 Internal thermal overload tripped 6 Compressor malfunction	1 Determine reason and take correct action 2 Determine type and cause of shutdown & correct it before resetting safety switch 3 Repair or replace 4 Reset operation temperature setpoint. 5 Wait until compressor cools down for reset. 6 Check compressor motor winding
Coil not clearing of frost during defrost cycle.	1 Heater malfunction 2 Not enough defrost cycles per day	1 Check heater operation 2 Adjust defrost control
Ice accumulating in drain	1 Defective heater 2 Drain line plugged.	1 Check or replace 2 Clean drain line.
Display screen flashes & hum	See alarm indicator	See alarm indicator

Identify parts, controls and accessories of cold storage plant

Objectives: At the end of this exercise you shall be able to
- **identify all components in refrigeration system**
- **identify, controls and safety devices with specifications in cold storage refrigeration system.**

Requirements

Equipment/Machines
- Cold storage plant 5TR

Materials
- Hand woollen gloves - 1 Set.
- Woollen rain coat - 1 No.
- Gum boots - 1 Set.
- Woollen cap - 1 No.

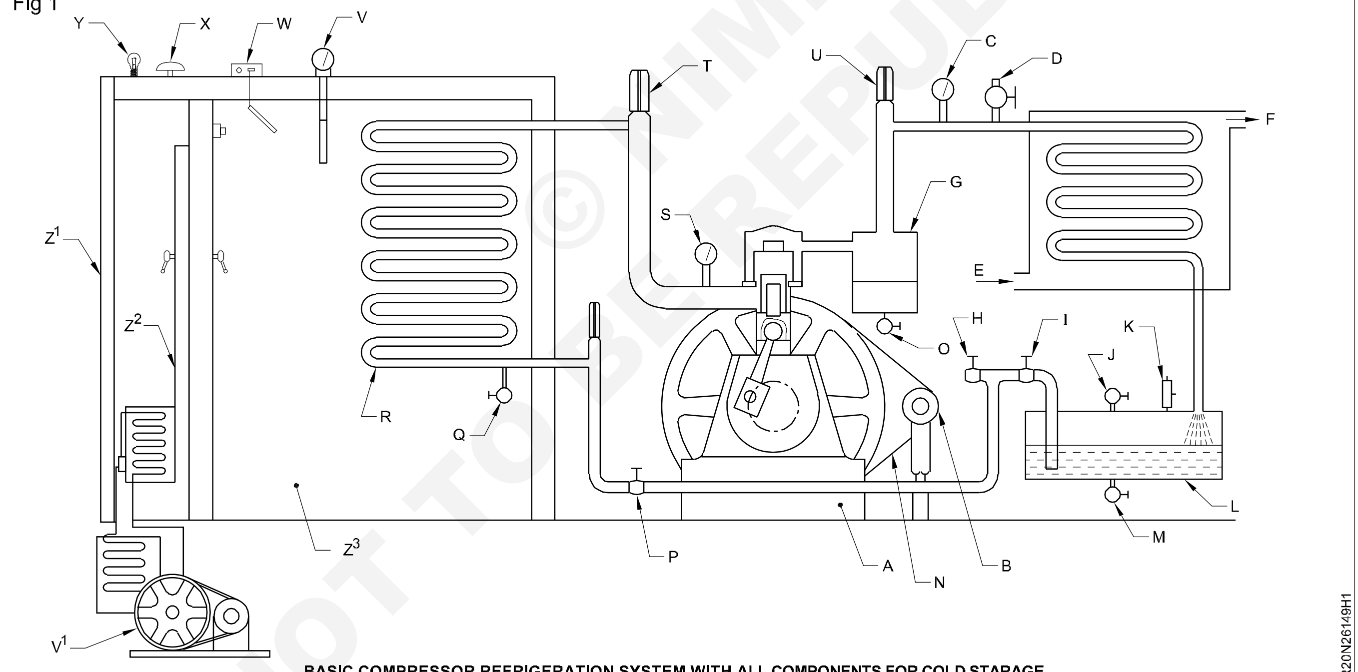
PROCEDURE

TASK 1 : **To identify all components in refrigeration system (Fig 1)**

1 Identify the names of labelled parts of a refrigeration system.

2 Record in the table 1 of record sheet.

Fig 1



BASIC COMPRESSOR REFRIGERATION SYSTEM WITH ALL COMPONENTS FOR COLD STARAGE

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TASK 2: **To identify controls, and safety devices with specifications in cold storage refrigeration system**

1 Identify the names of labelled parts and specification in cold storage and refrigeration system.

2 Record in the table 2 Record sheet.

— — — — — — — —

Record Sheet

Table 1

Labelled Alphabet	Name of the part identified	Function
A		
B		
C		
D		
E		
F		
G		
H		
I		
J .		
.		
S		
V		
V1		

Table 2

Labelled Alphabet	Name of the controls/ safety devices identified	Function
K		
P		
T		
U		
W		
X		
Y		
Z^1		
Z^2		
Z^3		

Service and operation of cold storage plant

Objectives: At the end of this exercise you shall be able to
- **check compressor and drive system**
- **clean the condenser (water cooled shell and tube condenser water through tubes)**
- **check clamping of thermostatic expansion valve sensing bulb**
- **defrost evaporator, clean fins or tubes externally**
- **check low pressure, high pressure switch, thermostat and pressure gauges**
- **operate cold storage plant.**

Requirements

Tools/Instruments

• Double end spanner set 4 to 27mm	- 1 Set.
• Adjustable wrench 6”	- 1 No.
• Chisel 6”	- 1 No.
• Hammer 500 gms	- 1 No.
• Screw driver	- 1 No.
• Cutting plier	- 1 No.

Equipment/Machines

• 5 TR cold storage complete with controls and cooling tower	- 1 No.

Materials

• Refrigeration lub-oil	- as reqd.
• Plastic bucket	- 1 No.
• Funnel with mesh	- 1 No.
• Tube cleaning brush with rod (reqd. size)	- 1 No.
• Descaling system (if necessary)	- 1 Set.
• Rubber sheet	- as reqd.

PROCEDURE

TASK 1 : **Check compressor and drive system (Fig 1)**

1 Ensure that the compressor is at rest and cooled to ambient temperature.

2 Put off the power main supply.

3 Check the oil level if necessary, top up the level.

4 Check the ‘V’ belt tension and tighten.

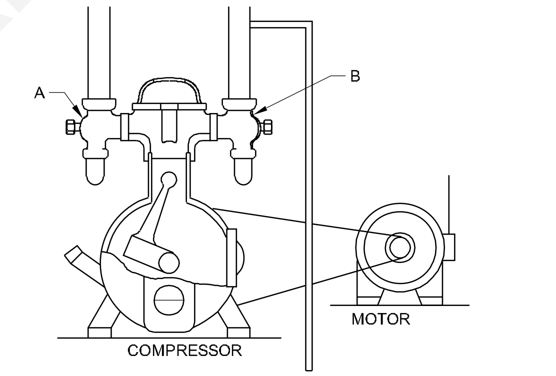
5 Check the motor terminals for tightness.

6 Check starter wire connections for tightness.

7 Leak test the compressor joints with soap solution and rectify tighten all bolts and compressor and motor base bolts.

8 Test the leakage of shaft seal.

Fig 1



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TASK 2 : **Clean the condenser (water cooled shell and tube condenser water through tubes).**

1 Descale the condenser.

2 Drain water from cooling tower sump clean sump check the water pump and clean spray nozzles.

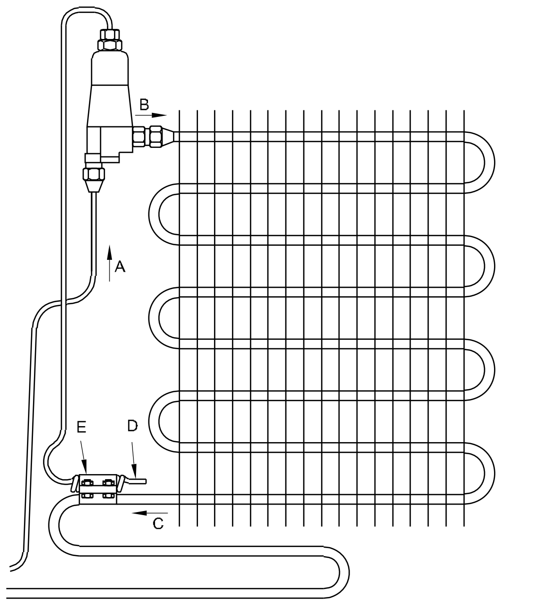
— — — — — — — —

TASK 3 : **Check clamping of thermostatic expansion valve sensing bulb (Fig 1)**

1 Loosen the clamp E screws with the help of screwdriver and cutting plier and lift the bulb D.

2 Clean the pipe seating area with emery paper wipe of dirt with banian cloth.

Fig 1



EVAPORATOR WITH THERMOSTATIC EXPANSION VALVE INDICATES SENSING BULB

3 Install sensing bulb and tighten the clamp screws gently.

> **Caution: Be careful when lifting/handling sensing bulb. Mishandling may lead to 'crack' on sensing bulb and valve become useless.**

— — — — — — — —

TASK 4 : **Defrost evaporator, clean fins or tubes externally.**

1 Defrost evaporator.

2 In case of finned evaporator clean fins with soft brush. If pipe evaporator clean with damp cloth and wipe dry.

— — — — — — — —

TASK 5 : **Check low pressure, high pressure switch, thermostat and pressure gauges (Fig 1)**

1 Check low pressure switch and thermostat.

2 Check pressure gauges.

3 Isolate the gauge from system and loosen the gauge fittings.

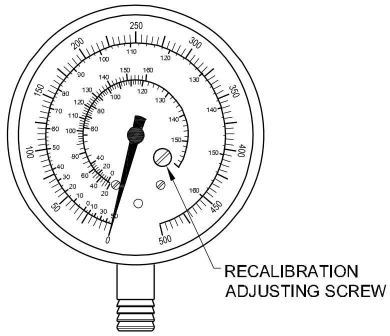
4 It should read the needle should stop at zero.

5 If the needle is below zero or above then the recalibration screw to be adjusted.

6 Install the gauges open the gauge isolation valve and read pressure.

7 Close the isolation valve loosen the gauge it should read zero. If not replace the gauge with new gauge.

Fig 1



PRESSURE GAUGE WITH RECALIBRATION ADJUSTING SCREW

— — — — — — — —

TASK 6 : **Operate cold storage plant**

I Follow the procedures before operation

1 Check and open all the valves in the refrigeration system, condenser water valves and check the oil level of the compressor is sufficient.

2 Check the water level at cooling tower and ensure the make-up valve float ball is in function.

3 Check the water strainers, clean it if necessary.

4 Check the crank case of the compressor is warm, if provided with crankcase heater.

5 Close the doors and windows, provided at cold room before start the plant.

6 'On' the breaker, check the supply voltage at panel board is with in permissible limit.

II 'Start' and 'Stop' the plant with sequence

1 Start the condenser water pump, release the air-lock and check the water pressure is, as required.

2 Check the cooling tower fan's rotation is free manually, check the safety guard has fixed in firm, then start the cooling tower fan.

3 Switch 'on' the compressor control switch, and the refrigerant solenoid valve at the liquid line also simultaneously 'on'.

4 If the starter is provided with step (speed) control, raise it gradually with appropriate method as in manufacture's guide.

5 Check the compressor oil pressure is reaching according to the desired level, and the level to be maintained 40 to 50% in the sight glass. (Fig 4)

6 Take readings of all the pressures and temperatures in the given log sheet, after the plant stabilize, approximately after 1 hour of operation.

7 Analyse the plants performance with the parameter readings, compare with manufacturer's manual, check the current drawn by the compressor motor, evaporator fan motor and the cooling water circulation pump's motors.

8 If any changes or abnormalities, inform to instructor, find the causes and take remedial actions.

9 Take varies readings in proper interval (every hour) and check the difference in temperature & pressure, vary as per the load and ambient temperature.

10 Whenever the plant has to be stopped, first switch 'off' the refrigerant solenoid, automatically the plant will trip on low pressure cut-out, as the system gets pump down.

11 Then switch 'off' the compressor's main switch.

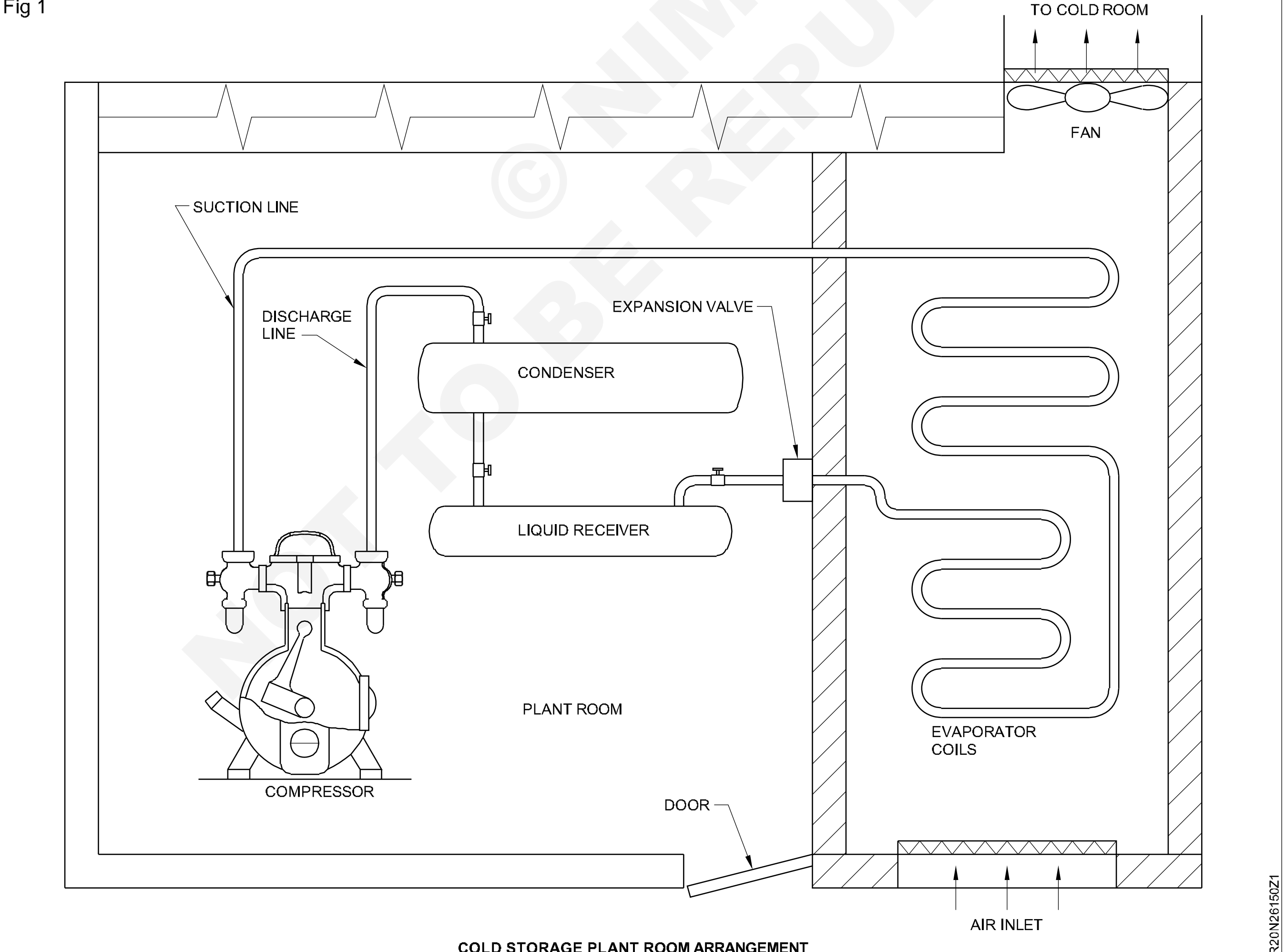
12 Check the crankcase heater is started in auto and observe it works, cut out and cut in as per the required temperature.

13 Stop the condensing water pump and cooling tower fans.

14 Put "Off" panel supply breaker, if the plant is going to idle for long time.

15 Close the water line valves to the condenser cooling.

Fig 1



COLD STORAGE PLANT ROOM ARRANGEMENT

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Check the refrigeration system of the cold storage plant

Objectives: At the end of this exercise you shall be able to
- **identify all components in refrigeration system**
- **identify, controls and safety devices with specifications in cold storage refrigeration system.**

Requirements

Equipment/Machines

- Cold storage plant 5TR

Materials

- Hand woollen gloves - 1 Set.
- Woollen rain coat - 1 No.
- Gum boots - 1 Set.
- Woollen cap - 1 No.

PROCEDURE

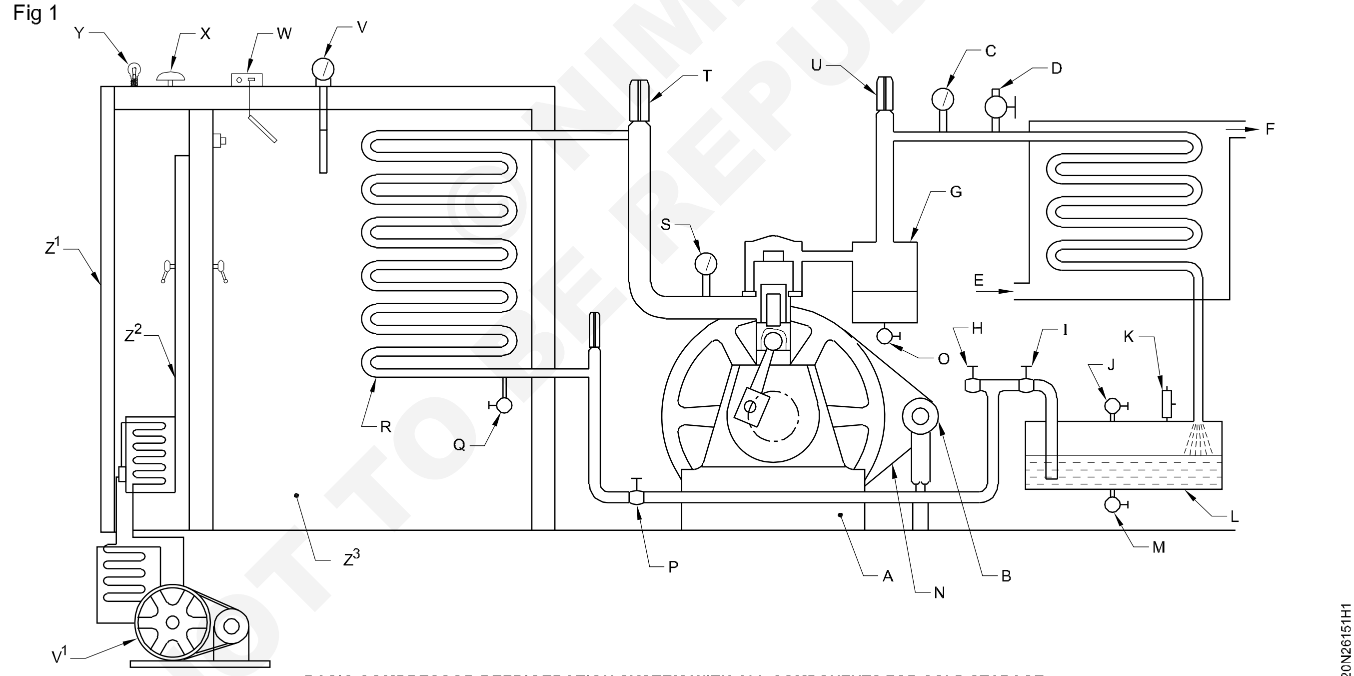
TASK 1 : **Identify all components in refrigeration system** (Fig 1)

1 Identify the names of labelled parts of a refrigeration system.

2 Check the function of each parts.

3 Record in the table 1 of record sheet.

Fig 1



BASIC COMPRESSOR REFRIGERATION SYSTEM WITH ALL COMPONENTS FOR COLD STARAGE

— — — — — — — —

TASK 2: **Identify controls, and safety devices with specifications in cold storage refrigeration system**

1 To identify the names of labelled parts and specification in cold storage and refrigeration system.

2 Check the function of each controls / devices

3 Record in the table 2 Record sheet.

Record sheet

Table 1

Labelled Alphabet	Name of the part identified	Function
A		
B		
C		
D		
E		
F		
G		
H		
I		
J	.	
.		
S		
V		
V1		

Table 2

Labelled Alphabet	Name of the controls/ safety devices identified	Function
K		
P		
T		
U		
W		
X		
Y		
Z^1		
Z^2		
Z^3		

Measure temperature and pressure of cold storage

Objectives: At the end of this exercise you shall be able to
• take reading of the parameters and compare with specifications.

Take readings of the parameters and compare with specifications.

1 Take the readings of the parameters after one hour of operation. Record the suction and discharge pressure of the compressor.

2 Record condenser inlet and outlet pressure and temperatures.

3 Record cooling tower water inlet and outlet temperature.

4 Record evaporator, cold room temperature.

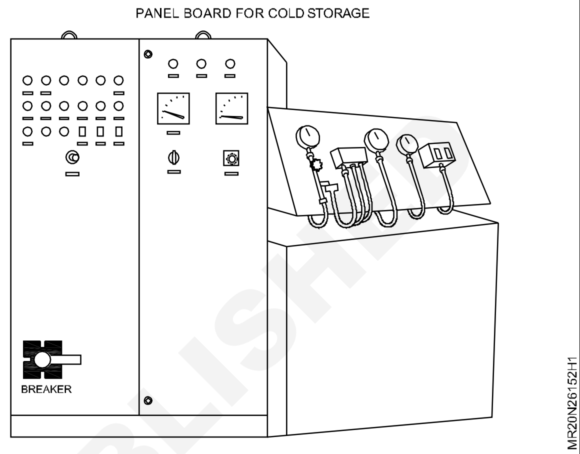
5 Check the volts and record amperage shown in the panel board.

6 Check with tong tester for the evaporator fan's current amperage and record.

7 Compare the readings with, manufacturer's specification of parameter readings.

8 If any of the reading is abnormal with actual measure, find the cause for it.

Fig 1



Evacuate cold storage by two stage vacuum pump and gas charging

Objectives: At the end of this exercise you shall be able to
• Evacuate and gas charge the system.

Evacuate and gas charge the system

1 Re-connect all the controls and relief valves.
2 Connect the vacuum pump to the suction service valve.
3 Check that all the systems cycle, valves are open and the solenoids are also open.
4 Run the vacuum pump around 12 hours and check the reading in the compound gauge. If it reaches to the recommended vacuum pressure (760 mm approx.) close the charging hose hand shut off valve, allow the system to stand under vacuum for 24 hours, after stop the vacuum pump.
5 Check the vacuum reading, confirm there is no leak in the system.
6 Disconnect the vacuum pump and charging line after back seat the suction service valve.
7 Connect a drier with the charging line to recovered gas cylinder, purge the line before connecting to suction service valve.
8 Check up all the parameters, safety devices to the system properly, keep compressor oil level perfect,
9 Check the fan, motor bearings, supply water line to condenser, lubricate the pumps, and other normal maintenance check ups.
10 Slowly open the cylinder valve and back seat crack the suction service valve.
11 Keep the gas cylinder in slanting position and allow the liquid refrigerant to charge in the system.
12 Continue charging till the gas rushing into system (feed the charging line) when the flow reduce, lift the cylinder carefully upside down.
13 After complete idle charging close the cylinder valve, lift the cylinder make it to stand in normal position as the valve side up.
14 Start the compressor and record the pressure & temperature.
15 If the recovered gas is not sufficient to get the required evaporative temperature and suction pressure, connect a new cylinder and top up only gas (not liquid) to the required amount.
16 After complete charge, close the charging line valve, cylinder valve disconnect and cover with valve cap. Close the service port also with the seal cap.

Exercise 2.7.154

Identify DBT, WBT, RH & other properties by using psychrometric chart

Objectives: At the end of this exercise you shall be able to
- **read psychrometric chart**
- **calculate DBT,RH,WBT Dew point temperature, moisture content, specific volume , enthalpy using psychrometric chart.**

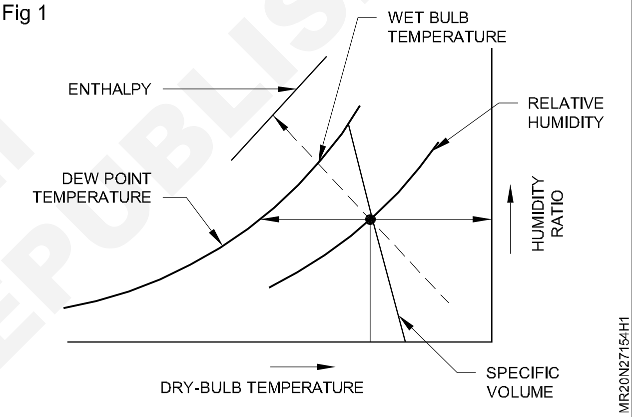
Requirements			
Tools/ Instruments		**Materials**	
• Plastic rule 300mm	- 1 No.	• Psychrometric chart	

PROCEDURE

TASK 1 : **Practice of reading psychrometric chart (Fig 1)**

1 Trace out DBT, WBT line.
2 Trace out specific volume & R.H line.
3 Trace out enthalpy line
4 Find out dew point & moisture content line.

Fig 1



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TASK 2 : **Calculate DBT, RH, Dew point temperature, Moisture content, Specific volume, Enthalpy using psychrometric chart (Fig 1)**

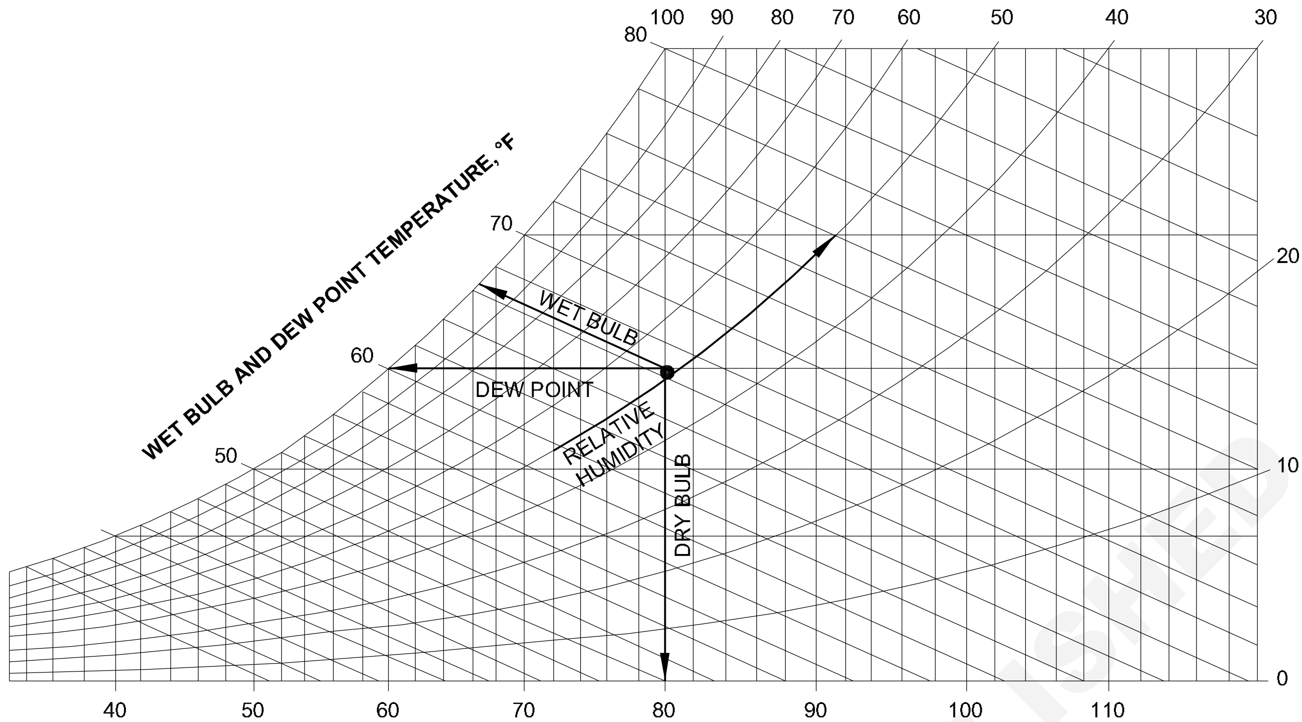
1 Apply Ex 257, average indoor data of DBT & WBT.
2 Find out the intersection point.
3 Find out RH, specific volume and record in sheet - 1.
4 Find out dew point temperature, moisture content & record in record sheet - 1.
5 Find out enthalpy & record in record sheet -1.

Record Sheet - 1

S.No.	Location	DBT	WBT	R.H.	D.Point	S.Volume	S.Enthalpy	M.contain
1	In door data							

NOTE : This exercise may be done after Ex.No 4.1.257

Fig 1


RELATIVE HUMIDITY, %
100
90
80
70
60
50
40
30
80
70
60
50
20
10
0
WET BULB AND DEW POINT TEMPERATURE, °F
WET BULB
DEW POINT
RELATIVE HUMIDITY
DRY BULB
40
50
60
70
80
90
100
110
DRY BULB TEMPERATURE, °F
MR20N27154X1

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Use psychrometer for finding DBT and WBT

Objectives: At the end of this exercise you shall be able to
- **set the psychrometer to measure**
- **measure DBT & WBT at out door**
- **measure DBT & WBT at in door**
- **measure DBT & WBT at supply and return.**

Requirements

Tools/ Instruments	Materials
• Sling psychrometer fitted with thermometer in fahrenheit scale / centigrade scale	• Cotton piece • Condition close room

PROCEDURE

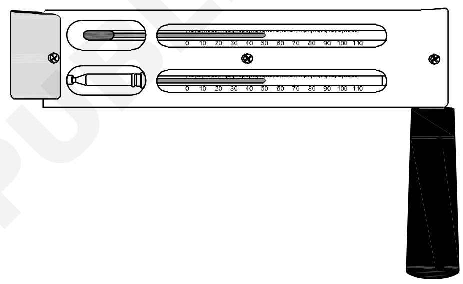
TASK 1 : **Set the sling psychrometer (Fig 1) for measuring**

1 Clean sling psychrometer with clean cloth

2 Check sling psychrometer respecting physical damage of case and thermometer.

3 Check free movement of sling psychrometer by holding and rotating handle.

Fig 1



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TASK 2 : **Measure DBT & WBT at our door (Fig 1)**

1 Set thermometer reading with your sight angle.

2 Fill water in wet bulb thermometer port and check wick/ cloth wetted the bulb of thermometer.

3 Protect dry bulb thermometer from direct radiation.

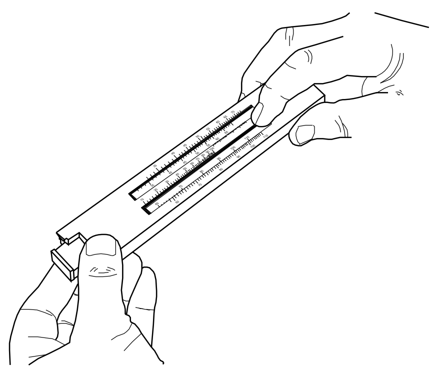
4 Hold handle firmly.

5 Walk and rotate sling psychrometer in open area.

6 Stop rotating sling psychrometer after few minute.

7 Note down WBT at first, then DBT.

Fig 1



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TASK 3 : **Measure DBT & WBT at in door**

1 Set thermometer reading with your sight angle.

2 Hold handle firmly.

3 Walking and rotating sling psychrometer inside the room take reading in five spot.

4 Note down WBT at first, then DBT.

5 Record all the reading in record sheet.- 2

— — — — — — — —

TASK 4 : **Measure DBT & WBT of supply air and return air**

1 Set thermometer reading with your sight angle.

2 Hold handle firmly,

3 Place sling psychrometer thermometer bulb on supply air inlet.

4 Note down WBT & DBT with out disturbing position of sling psychrometer.

5 Record all the reading in record sheet.-2

Record Sheet - 2

S.No.	Location	DBT	WBT	Average	
				DBT	WBT
1	Outdoor			X	X
2	Indoor east				
3	Indoor west				
4	Indoor north				
5	Indoor south				
6	Supply grill right side				
7	Supply grill middle				
8	Supply grill left				
9	Return grill right				
10	Return grill middle				
11	Return grill left				

Measuring air flow using anemometer

Objectives: At the end of this exercise you shall be able to
- **practice by using anemometer**
- **measure air flow and velocity.**

Requirements

Tools/Instruments

- Connector screw driver - 1 No.
- Double end spanner - 1 Set
- Combination plier - 1 No.

Materials

- Vane type anemometer - 1 No.
- Fan delivering air - 1 No.

PROCEDURE

TASK 1 : **Practice by using of anemometer**

1 Take out the anemometer from its cover.

2 Read carefully the instructions given in the instruction manual.

3 Understand about the use of every switches provided in the anemometer.

4 Switch on the anemometer control unit and observe the reading shown by it.

5 Place the vane unit against any air flow and observe its rotational speed.

6 Complete the record sheet - 1 by noting down the reading from the control unit after holding the vane unit at different fan or blower outlets.

7 Switch off the control unit.

8 Place the control unit and vane unit safely into the anemometer box.

Record sheet 1

Sl. No.	Time		Reading in m/s
	Switch ON	Holding	
1			
2			
3			

— — — — — — — —

TASK 2 : **Measure air flow and velocity using anemometer**

1 Take out the anemometer from the cover.

2 Switch on the control unit of the anemometer and observe the reading shown by the monitor.

3 Select the number of points (Locations) against which the vane unit to be placed.

4 Hold the vane unit against each selected location where air flow is taking place.

5 Note down the reading shown by the control unit and record it in to the record sheet. - 2 Find out average reading.

Record sheet 2

Location	Anemometer reading	Average reading
1		
2		
3		
4		

— — — — — — — —

TASK 3 : **Measure the air flow and velocity with anemometer (wide mill type)**

Dial (A) large dial scale reads air flow upto 50mts/sec.

Dial (B) Scale reads 50 mts/sec graduations. (Fig 1)

Dial (C) scale reads 500 mts/sec.

1 Place it carefully in the air stream at right angles to air flow. (Fig 2)

2 Watch the constant speed, reaches within a minute.

3 Trip the registering mechanism.

4 Start a stop watch at the same time.

5 Record the reading and the time

6 Compute the velocity of the air in mts/sec for the data obtained.

Example : If the reading is 75 mts for $^{1}/_{2}$ min, then for 1 minute = 150 mts/min.

7 Take several readings, then compute the average to ensure accuracy.

Fig 1

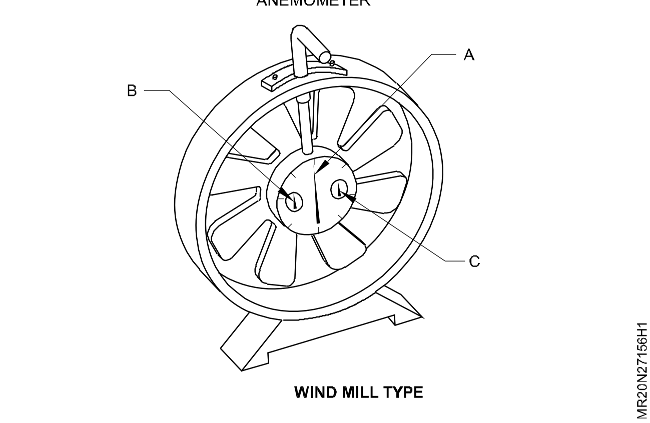
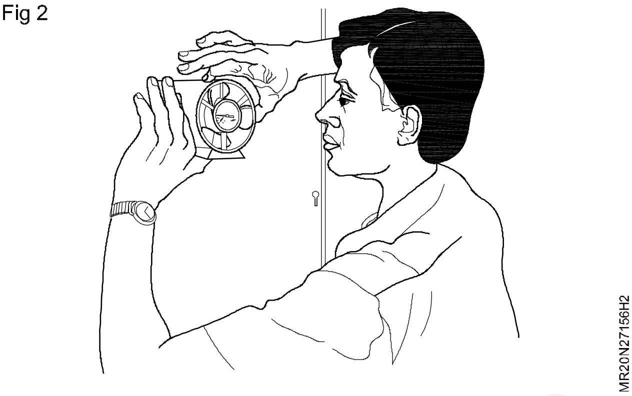


Fig 2



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Service of fans and blowers used in air conditioning system

Objectives : At the end of this exercise you shall be able to
- **service and maintain fans (blowers) in AHU (Air Handing Units)**
- **service and maintain fan in FCU (Fan Coil Units)**
- **service and maintain blowers for air-circulation at air-washers.**

Requirements

Tools/Instruments

- Double and spanner - 1 Set
- Ring spanner - 1 Set
- Wrench adjustable, length 150mm - 1 Set
- L-Allen key set, size 1.5 to 6.4mm - 1 Set
- Screw drivers, 6mm tip, length 150mm
  10 mm tip, length 250 mm - 1 No.
- Air blower (Hand set) - 1 No.

Equipment/Machines

- Central A/C plant's (5 TR)
- Air handling unit - 1 No.
- Fan coil unit - 1 No.
- Air-washer - 1 No.

Materials

- Clean cloth - as reqd.
- Nylon brush - as reqd.
- Grease (As recommended) - as reqd.
- Grease gun - 1 No.
- Velotmeter - 1 No.
- Psychrometer - 1 No.
- Drive belts according to the size - as reqd.
- Tong tester - 1 No.

PROCEDURE

TASK 1: **Service and maintain blower fan in AHU**

1 Stop the plant with sequence and the AHU after getting clearance from your instructor.

2 Open the blower - fan compartment (Housing)

3 Remove the guard and check the belt tension, (if it is belt driven)

4 Tighten the adjustment bolts and bring the belt to normal tension.

5 Check and tighten the base bolts and fan hub locking nut.

6 Change the new belt, If the belts are found worn out or too loose (same no.of belt) change the new belt.

7 Lubricate the fan-motor with recommended lubricant.

8 Lubricate the blower bearings and the shaft end bearings as per manufacturer's manual.

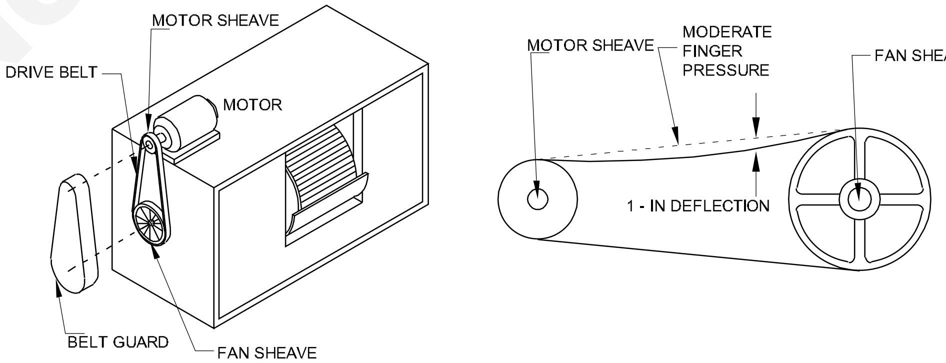
9 Wipe the blades of the blower gently with clean cloth.

10 Rotate the blower manually and check for free rotation, then assemble the housing (compartment).

11 Start the unit and check the current taken by blower motor is normal.

12 Check the air-velocity is correct as per requirement.

Fig 1



(a) FAN MOTOR COMPARTMENT (b) BELT TENSION CHECK

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TASK 2: **Service and maintain fan in Fan Coil Unit (FCU)**

1 Stop the unit after getting clearance from instructor.

2 Dismantle the fan-motor compartment.

3 Wipe the fan, motor, clean the filters, coils-fins.

4 Lubricate the motor and fan as recommended.

5 Check the fan's hub locking screw (nut) and base bolts and tighten it.

6 Rotate the fan manually, check for free rotation.

7 Wipe the total unit with clean cloth and assemble the cabinet.

8 Start FCU, check for the fan motor current with tong tester is normal, and check the air-velocity also.

— — — — — — — —

TASK 3: **Service and maintain blowers in air circulation at air-washer**

1 Stop the air-washer unit after getting clearance from instructor.

2 Open the service door of the air washer and dismantle the housing of the blower unit.

3 Use air blower (Hand machine), blow and clean the blower, blades and wipe the motor.

4 Remove the guard, check the tension of the belts tighten it if found loose.

5 Check the drive pulleys fittings, tighten the bolts and nuts of the base.

6 Replace total number of belts of same size, If the belts are worn out or too loose that cannot be adjusted in tightening.

7 Lubricate motor & bearings of the shaft with appropriate lubricants.

8 Wipe and clean totally and assemble the housing.

9 Start with low speed setting and check if there is any bearing noise. (If the bearings are noisy stop the unit and replace a new one of the same kind)

10 Check and clean the filters, spray nozzles and sump.

11 Start the unit after closing the service door properly.

12 Check the air velocity and humidity and record it.

13 Run the plant, after one hour of operation record the readings.

Record sheet

Table 1

Equipment	Fan motor	Air velocity	Humidity
AHU			
FCU			
Air washer			

Equipment :

No. of Belts changed :

Equipment :

Replaced bearing details :

Remarks :

Trainee : Instructor :

— — — — — — — —

Construct ducts as per duct layout drawing

Objectives : At the end of this exercise you shall be able to:
- **check and identify duct material**
- **measure and fabricate as per duct drawing**
- **connect the duct with the A/C unit to the conditioned room.**

Requirements

Tools/Instruments

• Centre punch 150mm	- 1No.
• Scissor	- 1No.
• Jumper	- 1No.
• Knife folder SS. 150mm	- 1No.
• Pop rivet gun	- 1No.
• Hand drilling machine	- 1No.
• Drill bit set	- 1No
• Sheet metal snipper	- 1No.
• Steel scale length 150cm	- 1No.
• Hammer nylon 300 gram wt	- 1No.
• Pencil and marker	- 1No.
• 1/4” bolts and nuts	- as reqd.
• Anemometer	- 1No.
• Manometer	- 1No.

Equipment/Machines

• Package Air conditioner	- 1No.

Materials

• Aluminium sheet or G.I sheet (Thickness and quantity as required)	
• Duct hangers and clamps	- as reqd.
• Rivets and self threaded screws	- as reqd.
• Canvas cloth	- as reqd.
• Insulation materials and covering cloth	- as reqd.
• Gasket covering duct joints	- as reqd.
• “L” angle supports	- as reqd.
• Dampers, diffusers grills	- as reqd.

PROCEDURE

TASK 1 : **Check and identify duct material**

1 Choose which type of metal sheet is suitable for duct, to the particular A/C unit (Aluminium or G.I. sheet).

2 Check the thickness and choose the sheets as per A/C manufacturer’s recommendation.

3 Determine the shape of the duct whether round of rectangle.

— — — — — — — —

TASK 2: **Measure and fabricate as per duct drawing**

1 Measure the route of the duct work and prepare duct drawing.

2 Calculate the number of sheets need to fabricate. (Always try to take duct in direct as possible to limit the length of the frictional loss)

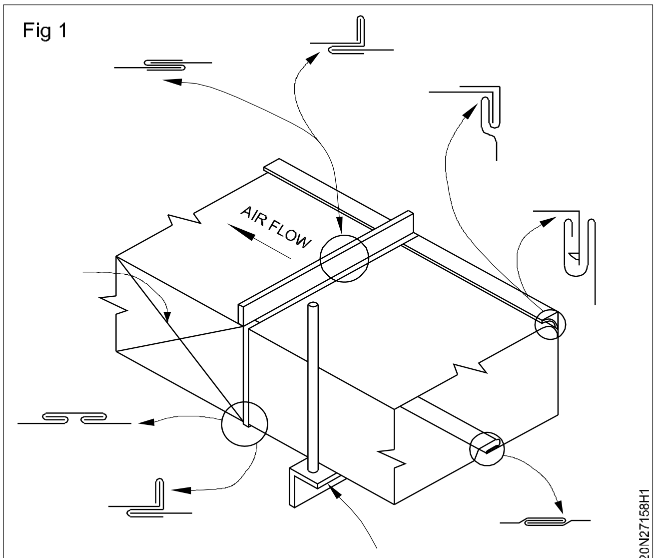
3 Minimise the number of bends in duct route, make elbows as per correct measurement.

4 Cut the sheet metals according to your design and shape of the duct.

5 Fold it, press to get the shape and length as per duct drawing.

6 Make the joints with rivets or bolts and nuts whichever applicable.

Fig 1



FABRICATING - ASSEMBLING G.I DUCT WORK

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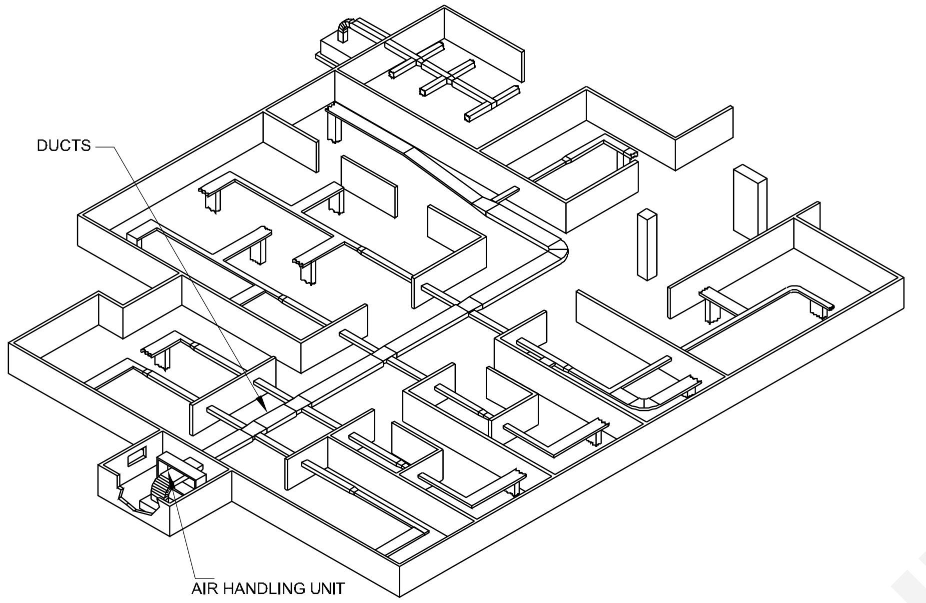
Fig 2



DUCT LAYOUT DRAWING

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TASK 3 : **Connect duct system with package A/C to conditioned room**

1 Cut the canvas to the correct measurement to connect blower outlet to duct inlet, to eliminate the vibration.

2 Keep the canvas in position and tighten both the joints with nut and bolts.

3 Make arrangement for the hangers to hold the duct lines.

4 Fix the duct arrangements one by one and connect the joints with gaskets (felts), tighten with nut and bolts fix the dampers wherever necessary.

5 Fix the "L" angles wherever necessary to support the duct lines and make it to hang by hangers.

6 Bring the final end of the duct line on top of the room ceiling and cover it with blind, cover the duct with insulations in non-conditioned areas.

7 Connect the duct branches to the diffusers to distribute the air supply to the room.

8 Check the passage on false celling for return air facility to the plant.

9 Check the air velocity to the main outlet and to the branches, and even static pressure of the conditioned room.

10 Record all the details in record sheet - 1 & 2.

Record sheet - 1
Materials and component used for duct system

MATERIAL DETAILS	**Canvas Qty**	**G.I Sheets Qty**	**Gasket materials Qty**	**No.of dampers, diffusers and grills**

Time taken :

Record sheet - 2

Air velocity in various check points

Blower router	Branch 1	Branch 2	Branch 3	Branch 4	Room static pressure

Remark

Trainee **Instructor**

— — — — — — — —

Insulate ducts

Objectives : At the end of this exercise you shall be able to:
- **select different insulating material based on their physical properties**
- **insulate ducts with glass wool**
- **insulate ducts with foam spray**
- **insulate ducts with foam sheet**
- **insulate ducts with expanded polystyrene (Thermocole).**

Requirements

Tools/Instrument

- Double ended spanner set 8 to 22 - 1 Set.
- Ring spanner set 5 to 22 - 1 Set.
- Wrench adjustable 150 mm - 1 No.
- Screw driver 6mm x 150mm - 1 No.
- Snipper sheet metal - 200mm
- Scissor - 1 No.
- Knife folded - 1 No.

Equipment/Machines

- Pre-fabricated ducts.

Materials

- GI sheet 22 SWG size 5x4" - as reqd.
- Foil-faced fiber glass - as reqd.
- Bitumen - as reqd.
- Glass wool - as reqd.
- Chicken wire - mesh - as reqd.
- Foam sheet/ Foam tool kit - as reqd.
- Thermocole 20mm thick - as reqd.
- Vapour retarder - as reqd.

PROCEDURE

TASK 1 : **Select different insulating material based on their physical properties**.

1 Identity various types of duct insulting materials like Glass wool, Cork, Thermocole, PUF, Fiber glass, Foam sheet etc, by taking the help of Instructor.

2 Note down the physical properties of the below mentioned insulating materials in Table - 1 consulting with the Instructor.

3 Identify and note down the physical property, permanence or water vapor transmission rates of vapour retarders/barrier with the help of Instructor.

Sl. No	Vapour retarders	Permanence of /m2/24h/ mm/kg
1	Bitumen coat	
2	Aluminium foil	
3	Advanced blythylene	
4	Chlorinated rubber paints	
5	Flat oil paints	

Table - 1

Sl . No	Insulating	Density (kg/m^3)	Thermal Conductivity (K)	Temperature range of application (°C)	Permanence of / m^2/24h/mm of Hg	Water absorption % by wt in 24hr
1	Polyurethane					
2	Thermocole					
3	Fibre glass					
4	Cork					
5	Foam concrete					

— — — — — — — —

TASK 2 : **Insulate ducts using glass wool as insulation**

1 Cement the duct joints before insulating .

2 Check the ductwork for leaks, and repair any that found.

3 Check for proper supply and return air temperatures.

4 Check for proper air pressure.

5 Check if there is any chance of moisture condensation on the duct.

> **Take greater care if moisture condensation can occur in case of glass wool insulation.**

6 Insulate the duct with glass wool, if there is no chance of moisture condensation.

7 Apply a uniform coating of bitumen or a solvent tree adhesive compound to the duct surface.

8 Stuck the glass wool to the coated surface.

9 Cover the insulation with a suitable vapor barrier, like aluminium fail.

10 Plaster the surface after spreading chicken - wire mesh as reinforcement.

11 Cover the insulation with perforated sheet or fiber glass cloth to prevent the flying of the fiber due to air velocity.

— — — — — — — —

TASK 3: **Insulate the ducts using spray foam**

1 Make sure that a spray foam insulation kit with insulating chemical tanks, nose pipes and spray bottle, with adequate instruction material are ready

2 Check the temperature of the insulation kit tanks to make sure that they are in proper temperature range. Normally the tanks should be between 65 to 85 degree Fahrenheit.

3 Clean the duct area to be insulated. Remove any dust and defines with a broom or a vacuum cleaner. Also wipe down the surface of the walls and studs with a damp cloth to remove cob webs and dust.

4 Space connect the spray hose to the tank (insulation).

5 Open the valves on the tanks by turning them counter clockwise so that the insulation foam can flow through the spray nozzle

6 Hold the spray nozzle about 12 to 16 inches away from the duct wall.

7 Spray the foam with a back-and-forth motion.

8 Not apply to much insulation at one spot

9 Apply a thin layer of about 2 inch of foam insulation for it to be effective.

10 Allow the foam insulation to dry for about 20 to 30 minutes.

11 Inspect the duct wall for missed spray spots.

— — — — — — — —

TASK 4 : **Insolate the ducts using readymade foam sheet**

1 Thoroughly clean the surface to be insulated.

2 Mark the measurements of the surface to be insulated on the sheet.

3 Cut the required site out of the foam sheet roll.

4 Apply contact adhesive to the insulation surface and to the duct surface.

5 Insulate lower surface of the duct first, then the side walls and lastly the top.

6 Use contact adhesive to join the edges of the foam sheet together.

— — — — — — — —

TASK 5 : **Isulate the ducts using expanded polystyrene (Thermocole)**

1 Coat the duct surface uniformly with bitumen.

2 Stuck the thermocole of 20mm thickness with the coating.

3 Do not use separate vapour barrier, as bitumen coating acts as one.

4 Finish the insulating with cement and plaster or metal cladding.

> **Caution:**
>
> **1 Foam insulation is highly flammable and release toxic smoke, if catches fire.**
>
> **2 Always use goggles and gloves while laying glass wool as insulation.**

— — — — — — — —

Service and maintain different filters

Objectives: At the end of this exercise you shall be able to
- **identify the air filters used in air conditioning system**
- **check the condition of air filter**
- **clean the dry type air filter**
- **clean the wet type air filter**
- **check performance of the filter.**

Requirements

Tools/Instruments

- Screw driver 6" - 1 No.
- Combination plier 6" - 1 No.
- Anemometer - 1 No.
- Thermometer - 1 No.
- Brass flat scraper - 1 No.

Equipment/Machines

- Air blower - 1 No.

Materials

- Cotton waste - 1 No.
- Water - as reqd.
- Mouth mask - 1 No.
- Plastic bucket - 1 No.
- Apron PVC - 1 No.

PROCEDURE

TASK 1 : **Identify the air filter**

1 Keep the different air filters on the work.

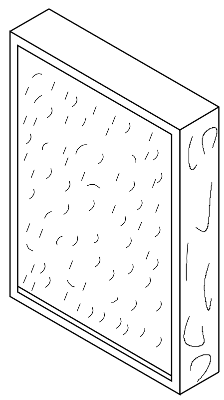
2 Identify the air filters one by one.

3 Note the name and entered into table1, after identification.

Table 1

Sl. No.	Type
1	
2	
3	
4	
5	

Fig 1



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TASK 2 : **Check the air filter**

1 Check the physical condition of air filter

2 Check the air passing through air filter

3 Check suction and discharge air flow (Before filter and after filter)

4 Check inlet and outlet temperature of the unit.

5 Record the air flow and temperature in record sheet.

Operation with dusty air filters reduces the cooling capacity and wastes energy.

Record sheet

Sl. No.	Air flow in cfm		Temperature in °C	
	Suction	Discharge	Inlet	Outlet
Before cleaning the filter				

— — — — — — — —

TASK 3 : **Clean the air filter (dry type)**

1 Check the condition of air filter.

2 Remove filter from the equipment.

3 Hold it in front of a light or even sunlight.

4 See through the filter light should be visible.

5 Take the filter to open space and tap the filter to the ground (wear goggles and mouth mask).

6 After removing all the course dust.

7 Then take the filter to washing area and rest against wall (inclined)

8 Fix flexible hose to water tap as shown in Fig 1.

9 Open tap and move nozzles up and down repeat this up and down to every pleat nozzles should be 25.0 mm away from filter element.

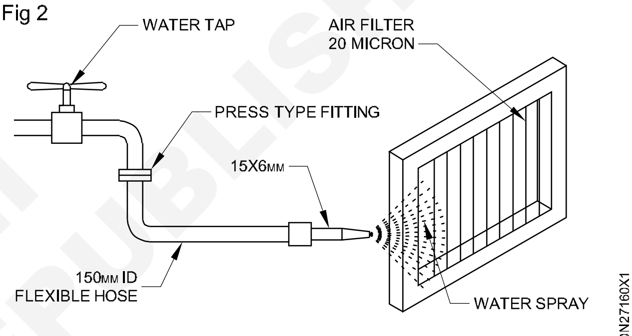
10 Allow all the water to drain.

11 Hold the filter by hand and blow air by air blower for dry.

12 Fix filter in position of equipment.

The same exercise to be repeated for all the filters in the equipment.

Fig 2



AIR FILTER CLEANING WITH WATER SPRAY

13 Start the unit and check the air flow with the help of velometer and record in record sheet.

Precaution

1 Read filter catalogue supplied by manufacturer.

2 Some of the filters are disposal so go as per the advice of filter supplier.

— — — — — — — —

TASK 4 : **Clean wet filter**

1 Remove the wet filter from AHU.

Caution : Switch "off" the blower motor before removing the filter.

2 Apply steam or hot water spray over wet filter for cleaning.

3 After remove oil and dirt particles from filter allow the filter for dry.

4 Apply oil film on the surface of the filter.

5 Keep back the filter at AHU.

— — — — — — — —

TASK 5 : **Check the performance of air filter**

1 Check the physical condition of air filter.

2 Check the air flow through filter.

3 Check the performance of dust absorption of filter.

If dust are coated on the surface of the evaporator coil it means that the air filter dust absorption is poor.

Record sheet

Sl. No.	**Air flow**		**Temperature**	
	Suction	**Discharge**	**Inlet**	**Outlet**
After cleaning the filter				

— — — — — — — —

Exercise 2.7.161

Placing of Filters

Objectives: At the end of this exercise you shall be able to
- **install the filter**
- **check the filter after installation.**

Requirements

Tools/Instruments

- Screw driver 6” - 1 No.
- Combination plier 6” - 1 No.
- Anemometer - 1 No.
- Thermometer - 1 No.

Materials

- Air filter - 1 No.

PROCEDURE

TASK 1 : **Install the filter**

1 Check the physical condition of air filter, before Installation

2 Clean the air filter before installation.

3 Fix the air filter at proper place.

— — — — — — — —

TASK 2 : **Check the filter after installation**

1 Check the alignment of filter after fixing.

2 Check the air leakage through outside of the filter.

3 Start the unit.

4 Check air flow and temperature.

5 Record it in record sheet.

6 Fix front grill in position.

Record sheet

Sl. No.	Air flow		Temperature	
	Suction	Discharge	Inlet	Outlet
Check after installing the filter				

— — — — — — — —

Identify various components of package A/C (with air cooled condenser)

Objective : At the end of this exercise you shall be able to
- **identify the component of package A/C unit.**
- **identify the control of package A/C unit.**
- **identify the electrical components of the package A/C unit**
- **identify electronic display panel.**
- **record the details in record in record sheet.**

Requirements

Tools/ Instruments

- Line tester - 1 No
- Screw driver 12" (300mm) - 1 No.
- Adjustable spanner (150mm) - 1 No.

Equipment/Machines

- Package A/C (with air cooled condenser)

PROCEDURE

TASK 1 : **Identify the mechanical components of package A/C (with air cooled condenser)**

1 Isolate the main switch of the package unit.

2 Unscrew the front and side panel screws with screw driver of the unit.

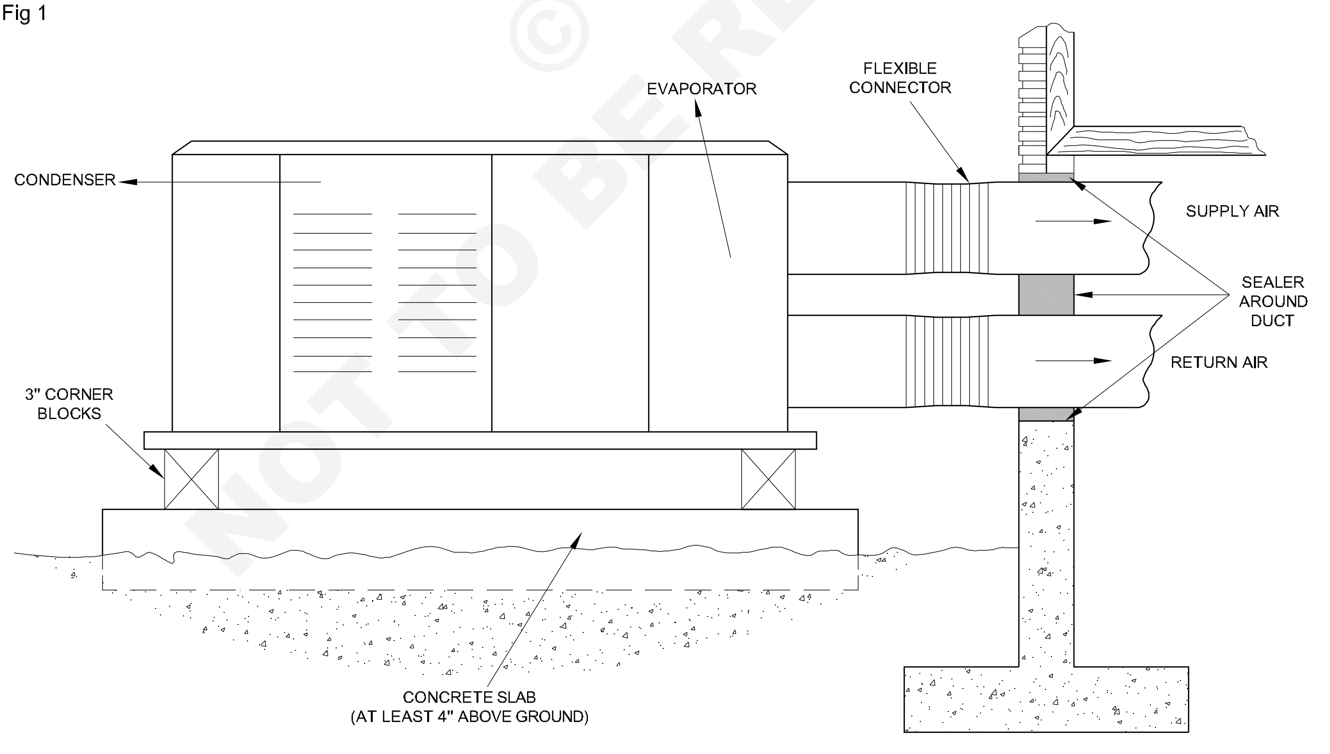
3 Remove the front panel from fan compartment

4 Remove the front panel from supply and return air grill.

5 Remove the front panel from machine compartment.

6 Identify the components and record the names, types, function and specification details.

Fig 1



PACKAGE AIR CONDITIONERS (WITH AIR COOLED CONDENSOR)

Sl.No.	Name of Component	Types of Components	Function of component	Specifications
1				
2				
3				
4				
5				
6				

— — — — — — — —

TASK 2 : **Identify the controls of package A/C**

1 Unscrew the electrical panel with screw driver.

2 Identify the controls provided.

3 Identify HP-LP cutout switch, expansion devices, thermostat, air flow switch, oil pressure safety switches, etc.

4 Record their function and specifications.

Sl.No.	Name of Controls	Function of the Controls	Specifications
1			
2			
3			
4			
5			
6			

— — — — — — — —

TASK 3 : **Identify the electrical components of package A/C**

1 Identify each components of the unit being electrically operated.

2 Identify the electrical components such as MCB, contactor, relay, overload protector etc.

3 Record your identification along with their specifications, types and ratings.

Sl.No.	Names of Electrical components	Types	Specifications	Ratings	Functions
1					
2					
3					
4					
5					
6					

— — — — — — — —

TASK 4: **Identify operating display panel**

1 Identify the microprocessor display panel.

2 Check the display panel by pressing / touching the panel button one by one.

3 Check by pressing button for condenser fan, evaporator fan motor blower.

4 Check for temperature setting through temperature set button.

5 Set safety cut outs in microprocessor control panel.

Fig 1

— — — — — — — —

TASK 5: **Record sheet**

Fill up the specification details for the package A/C (air cooled condenser)

1 Make/Model :

2 Type of installation :

3 Capacity (KW/TR):

4 Compressor Make/Type :

5 Compressor Motor type :

6 Compressor power :

7 Filter type :

8 Electric consumption :

9 Fan capacity : _________ cu/m per hour/(cfm)

10 Speed (rpm) : ________rpm

11 Weight of the unit :

12 Evaporator blower motor : ___________kw.

— — — — — — — —

Check electric circuit of package A/C (with air cooled condensers)

Objectives: At the end of this exercise you shall be able to
- **trace the wiring circuit of package A/C**
- **trace the circuit of motor starters**
- **check on-delay timer circuit.**

Requirements

Tools/Instrument

- Screw driver 100 mm long - 1 No..
- Line Tester - 1 No.
- Multimeter (digital) - 1 No .
- Tong Tester - 1 No.
- Voltmeter - 1 No.
- Clamp meter - 1 No.

Equipment/Machines

- Package unit with electrical wiring circuit.

Materials

- Insulation tape.

PROCEDURE

TASK 1 : **Trace the wiring circuit of package A/C**

1 Trace the wiring circuit in Fig 1, which shows a typical wiring diagram for a self-contained, air-cooled unit

2 Insulate the wires if it is necessary.

3 Check and clean the electrical contact points

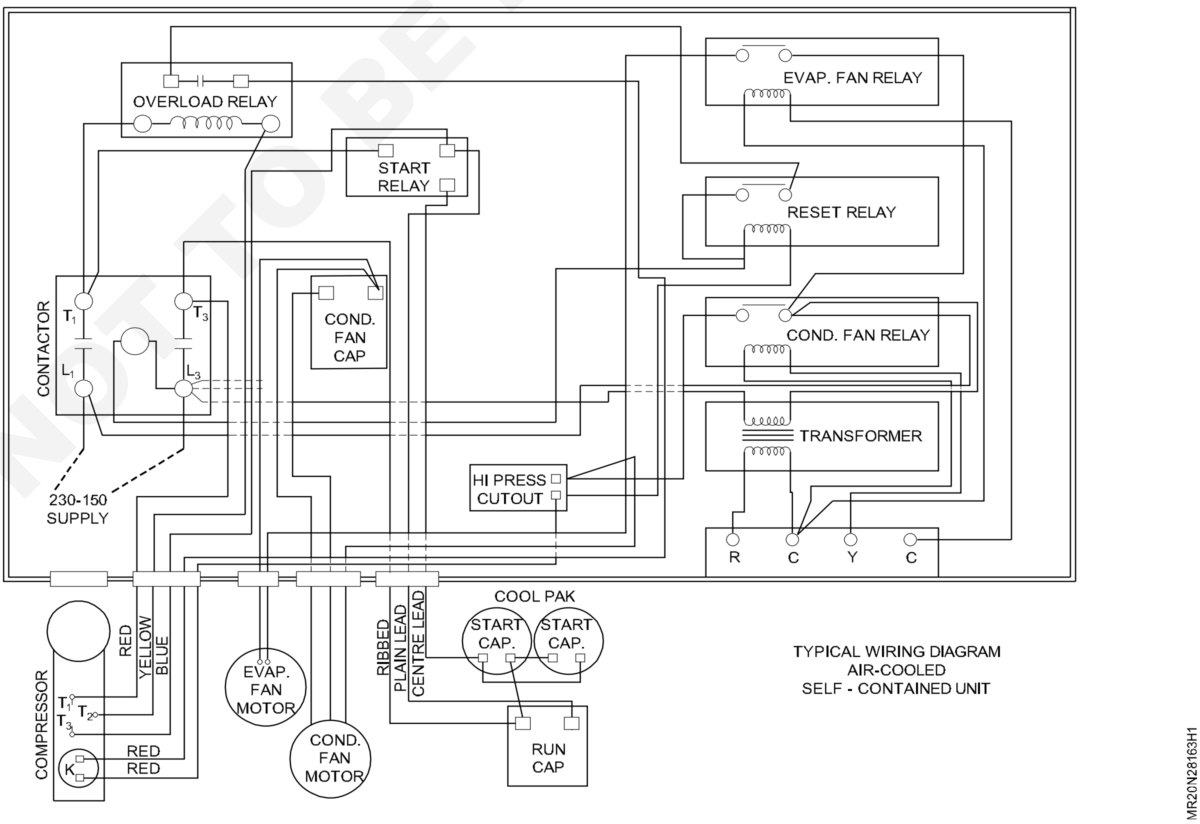
4 Tighten up any loose connection.

> **NOTE: Complete the wiring as described in the manufacturer's installation instructions.**

5 Check for the unit in grounded or not,

6 Check the nameplate characteristics of the unit against the available power supply.

Fig 1



NOTE :The units are usually completely wired by manufacturer for either 230- volts,1- phase, 50- cycle or 220-Volts, 3-phase, 50-cycle electrical characteristics power supply at the unit must be with in 10% of rated voltage and on poly phase units the phases must voltage balanced with in 3%.

NOTE : The Circuit of motor starter may not be available on the starter body. Instructor can refer to any external source or manual of the unit for the circuit

— — — — — — — — —

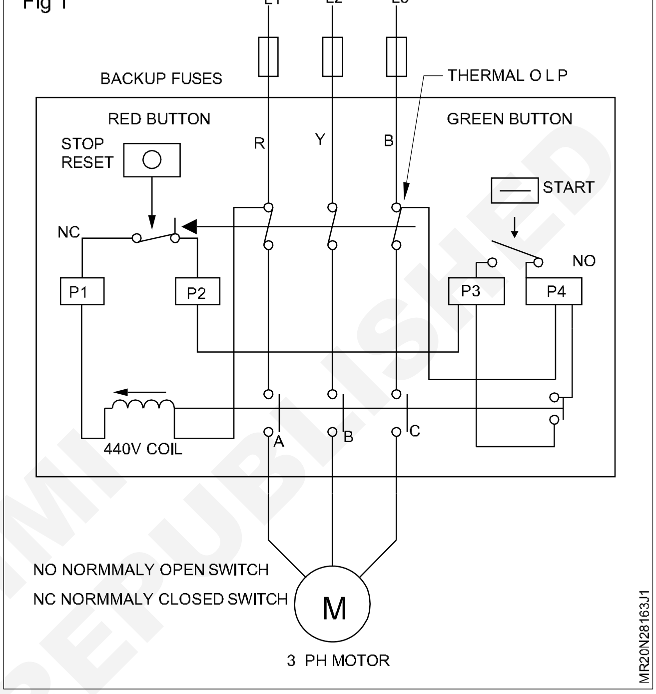
TASK 2 **: Trace the circuit of motor starters**

1 Trace and study the circuit of motor starters in Fig 1.

3 Phase motor starter DOL starter

When start button (green) is pressed phase B is connected to the coil through P4,P3,P2 and P1, coil magnetises attracting the plunger and making your contacts. The current passes to the coil through the right side contact (P3 and P4 are connected) press the start button only for starting.

Fig 1



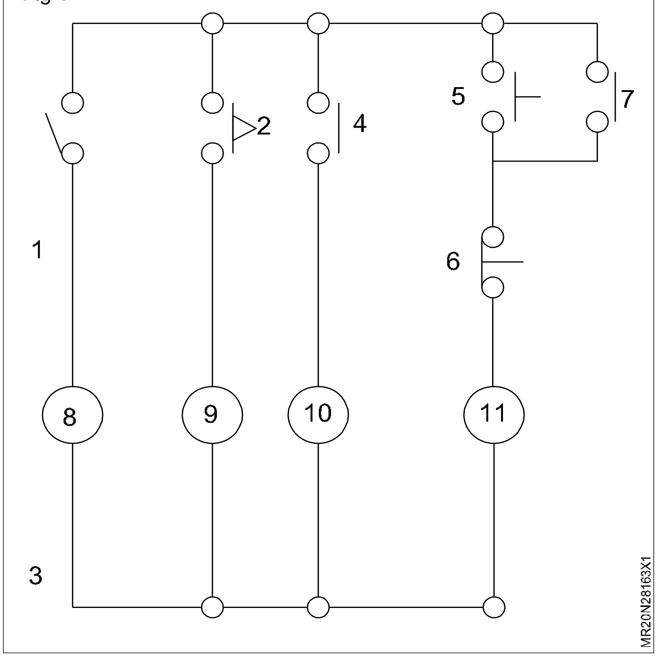
TASK 3 **: On-delay timer circuit**

1 Put the symbols on the circuit of the timer and record the names in the table.

NOTE : Refer theory book of the same exercise for things.

S.No	Labeter components	Function/Operation
1	P	
2	T	
3	N	
4	R'	
5	ON	
6	OFF	
7	R"	
8	V	
9	L	
10	T	
11	R	

Fig 1



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Identify various components of a package air conditioner with water cooled condenser

Objectives: At the end of this exercise you shall be able to
- **identify the mechanical components of package A/C**
- **operate electronic display panel**
- **identify the controls of the package A/C unit**
- **identify the electrical components of the package A/C unit**
- **record the specification/details.**

Requirements

Tools/ Instruments
- Line tester - 1 No.
- Screw driver 12" (300mm) - 1 No.
- Screw spanner 6" (150mm) - 1 No.

Equipment/Machines
- Package/air conditioner unit - 1 No.

PROCEDURE

TASK 1 : **Identify the mechanical components of package unit**

1 Isolate the main switch of package unit.

2 Unscrew the front panel screws with screw driver.

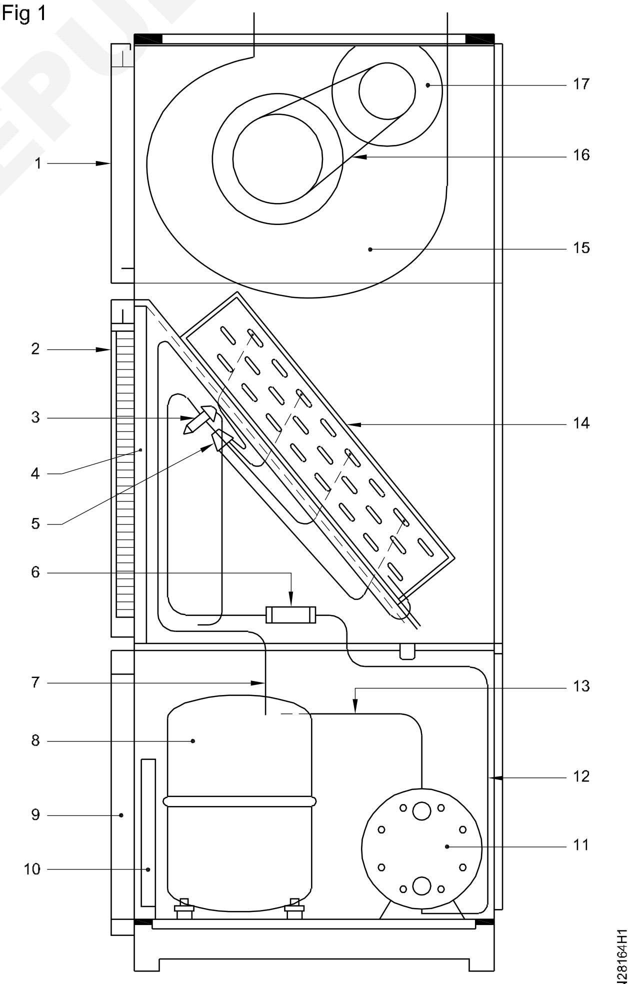
3 Remove the front panel from fan compartment.

4 Remove the front panel from return of air grill.

5 Remove the front panel from machine compartment.

6 Identify the components (Fig 1) and record the specification, types and functions of the mechanical components in Table -1.

Fig 1



PACKAGE AIR CONDITIONER-CROSS SECTIONAL VIEW

Table 1

Label No.	Name of the component	Specification/ Type	Function

— — — — — — — —

TASK 2 : **Operating electronic display panel (Sketch of microprocessor control band)**

1 Identify the microprocessor display panel

2 Check the display panel operation by pressing/ touching the panel button one by one.

a Line voltage in each phase.

b Switch to start condenser fan/pump & CT fan.

c Select the evaporator fan motor blower to start.

d Select the compressor motor/cooling mode on display panel to start.

e For checking/ setting temperature, select temperature set bottom.

3 May check phase current (individual) by separate ammeter.

4 For safety cut out also to be set. If microprocessor controls not provide this facilities.

If the start only observe the performance on display panel if require. (Fig 1)

Fig 1

— — — — — — — —

TASK 3 : **Identify the controls of the package unit (Figs 1 and 2)**

1 Unscrew the electrical panel with screw driver.

2 Identify the controls.

3 Identify the condenser water flow line and water pressure (cut out) switch.

Fig 1

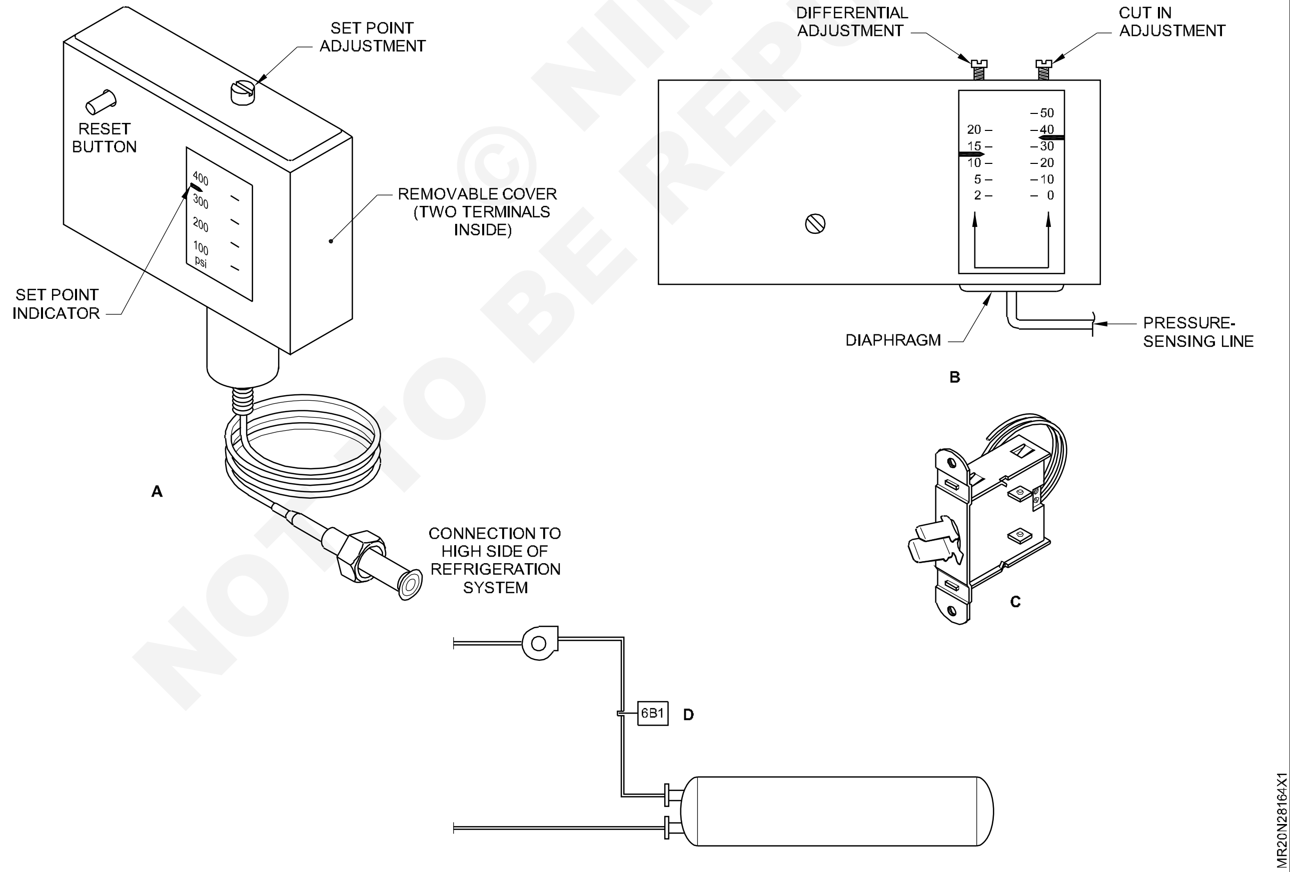
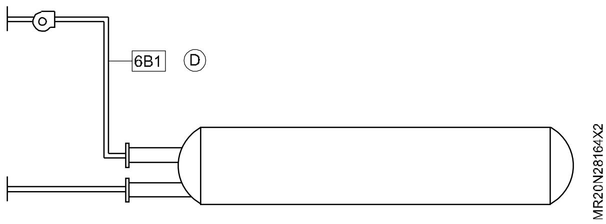


Fig 2



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TASK 4 : **Identify the electrical components of the package unit**

1 Identify the components which are electrically operated. Examples : Connector, MCB, Over load relay, contactors etc.

— — — — — — — —

TASK 5 : **Record the specification/ details in Record Sheet**

1 Fill up the specifications / details of the components and controls in the record sheet which is given at the end of the exercise.

— — — — — — — —

Record sheet

Packaged A/C unit

1 Make/Model :

2 Type (Air cooled/Water cooled) :

3 Capacity (KW/TR) :

4 Refrigerant :

5 Compressor make :

6 Compressor model :

7 Compressor power (K.W.) :

8 Filter size

9 Electric supply ....PH ....V .... HZ

10 Evaporator blower motor ....Kw.

11 Fan capacity ....Cu/m per hour /(CFM)

12 Speed rpm ....

13 Bare weight (kg) ....

Identify various components of split package A/C

Objectives: At the end of this exercise you shall be able to
- **identify the mechanical components of split package A/C**
- **identify the electrical components**
- **identify the various controls**
- **identify operating electronic display panel**
- **record the specification details in record sheet.**

Requirements

Tools/Instruments		**Equipment/Machines**
• Line Tester	- 1 No	• Split package A/C unit
• Screw driver 12'' (300mm)	- 1 No	
• Screw spanner 6'' (150mm)	- 1 No	

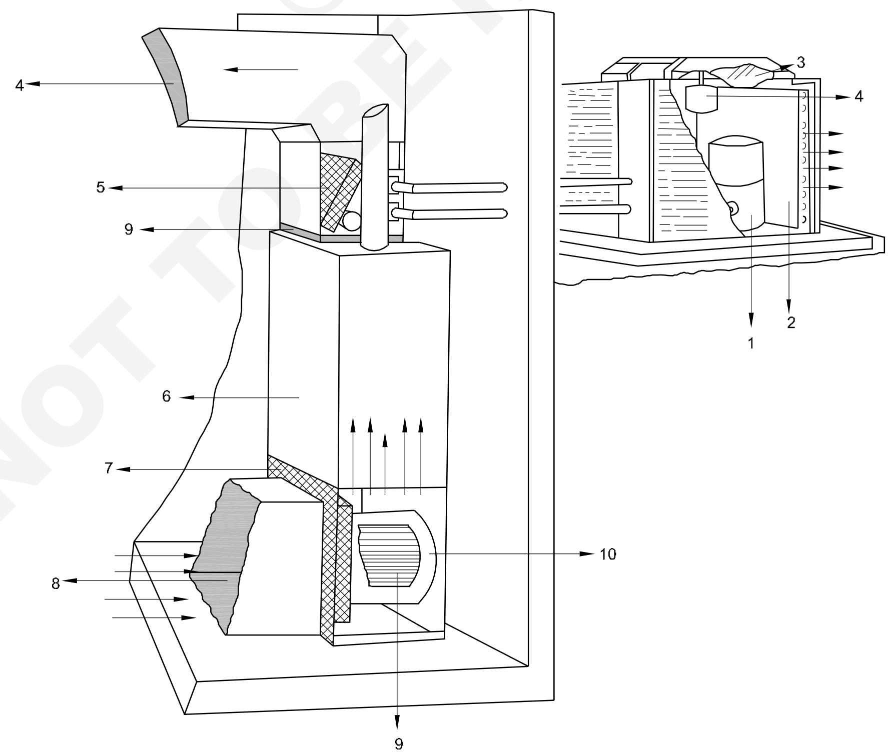
PROCEDURE

TASK 1: **Identify the mechanical components of split package A/C**

- Isolate the main switch of package unit.
- Open the front panel of ODU and IDU of split package A/C unit.
- Identify the mechanical components in the ODU and IDU
- Record the names types specification and function of each mechanical components in both ODU and IDU.

Fig 1 Showing the IDU and ODU components of split package A/C.

Fig 1



Sl.No	Names of Components	Types	Specification / Functions
1			
2			
3			
4			

Sl.No	Names of Components	Types	Specification / Functions
5			
6			
7			
8			

— — — — — — — — —

TASK 2: **Identify the electrical components of split package A/C**

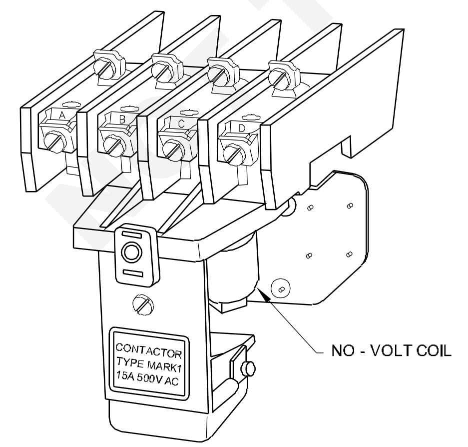
- Identify each components of the unit which are electrically operated.
- Identify the electrical components such as MCB, contactor, overload relay, overload protection propeller, and blower motors, compressor motor, capacitors connectors etc.
- Record your identification of electrical components along with their specification, types and ratings.

Table 2

Record sheet

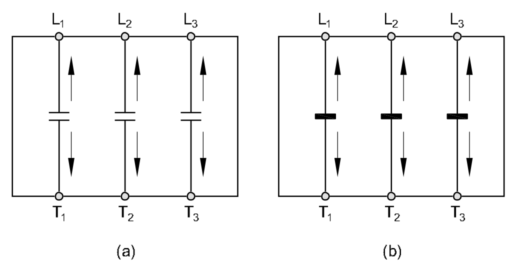
Sl. No	Names of Types	Specification (as per manual)	Ratings (as per manual)	Functions
1	Relay			
2	Over load Protector			
3	Contactor			
4	Compressor motors			
5	Propeller/ blower motor			
6	Capacitors			
7	Transformer			
8	Starters			

Fig 1



CONTACTOR

Fig 2



A THREE POLE CONTACTOR

(a) CONTACTS OPEN: CONTACTOR DE-ENERGIZED
(b) CONTACTS CLOSED: CONTACTOR ENERGIZED

Fig 3

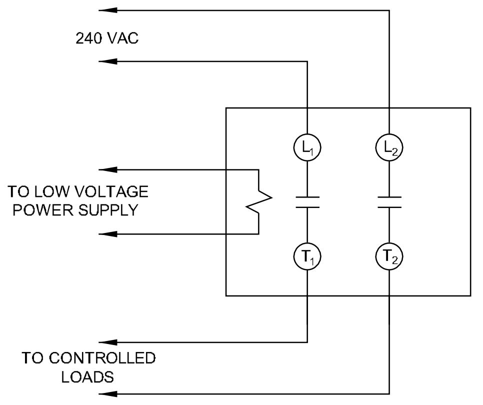
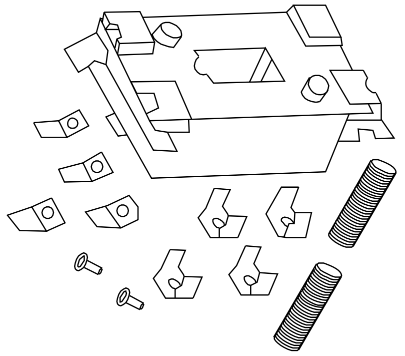
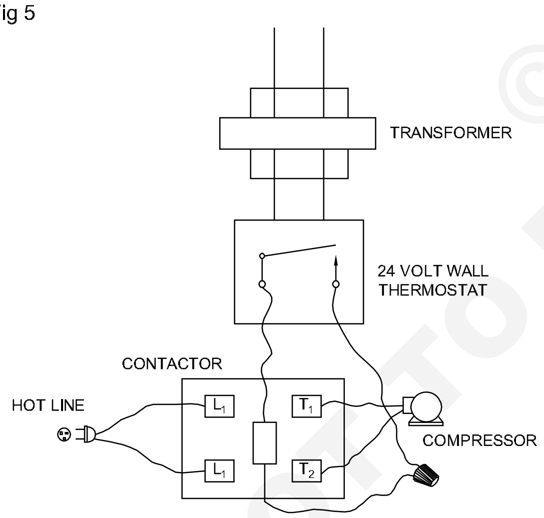


Fig 4



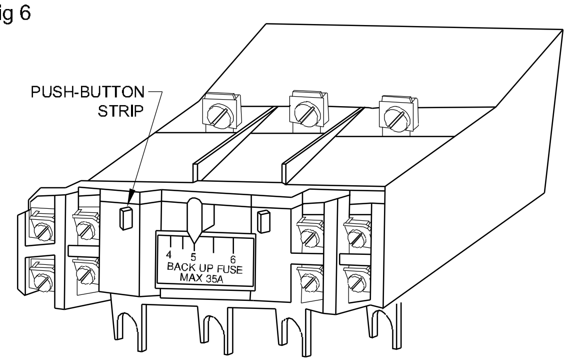
REPLACEMENT PARTS

Fig 5



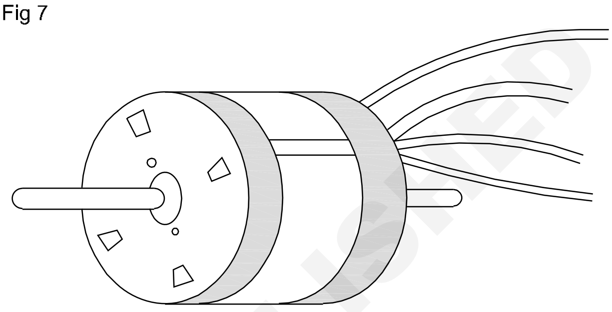
WALL THERMOSTAT CONNECTS 24 VAC TO CONTACTOR COIL ENERGIZING COMPRESSOR

Fig 6



OVERLOAD RELAY

Fig 7



A THREE-SPEED SHADED POLE FAN MOTOR

Fig 8

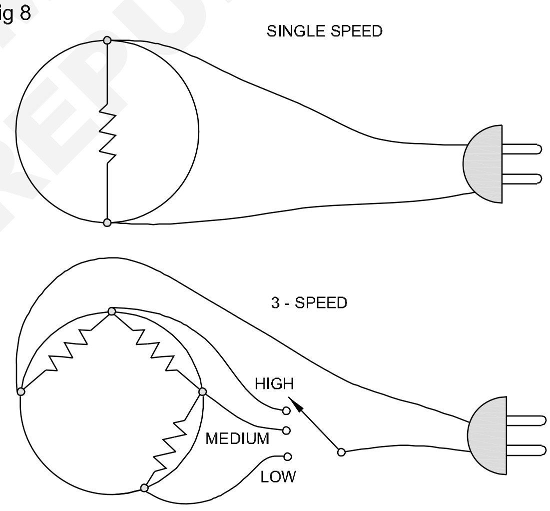
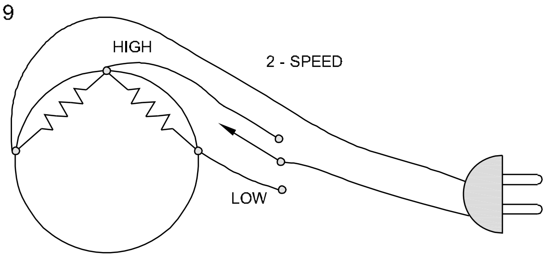


Fig 9



SHADED POLE FAN MOTOR SCHEMATICS

— — — — — — — —

TASK 3 : **Identify various controls**

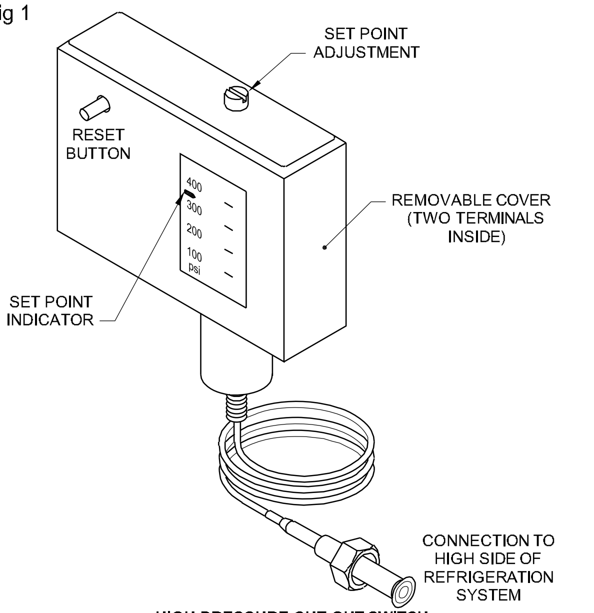
1 Unscrew the electrical panel with screw driver.

2 Identify the controls.

3 Identify the high pressure - low pressure cut out switch, dual pressure switch, sail switch (flow switch), Humidistat oil pressure failure switch, short cycle timer, thermostat, Thermostatic Expansion devices.

4 Record the names and functions of various controls.

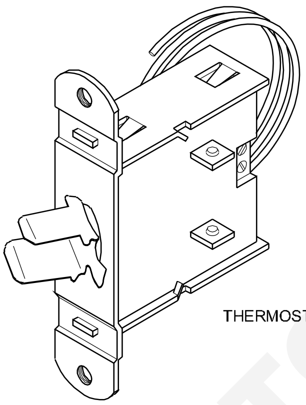
Fig 1



HIGH PRESSURE CUT OUT SWITCH

MR20N28165X1

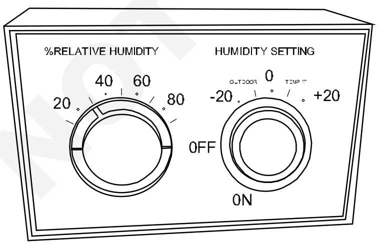
Fig 2



THERMOSTAT

MR20N28165X2

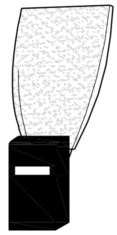
Fig 3



HUMIDISTAT

MR20N28165X3

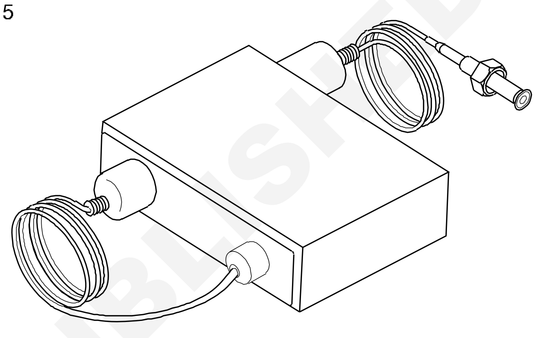
Fig 4



AIR FLOW SWITCH

MR20N28165X4

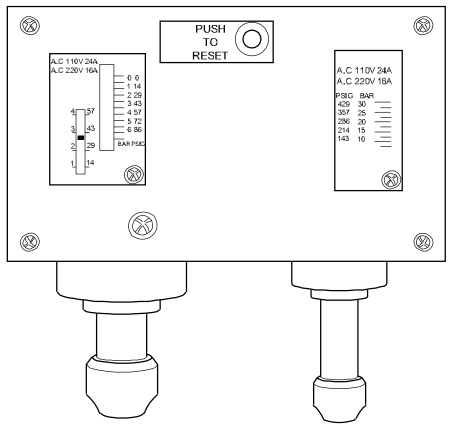
Fig 5



OIL PRESSURE SWITCH

MR20N28165X5

Fig 6



DUAL PRESSURE SWITCH

MR20N28165X6

TASK 4 : **Identify operating electronic display panel**

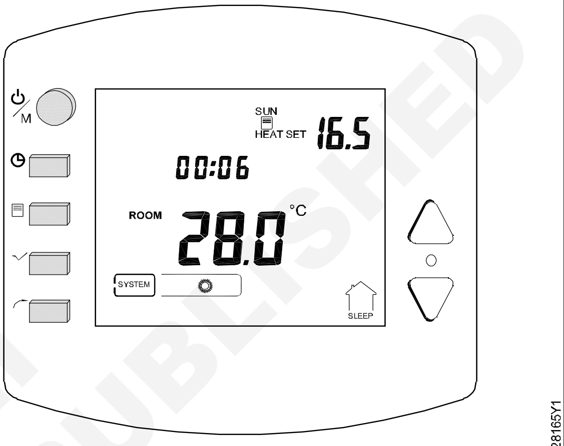
- Identify the micro processor display pannel.
- Check the display panel operation by pressing/touching the panel button one by one.
  a Line voltage in each phase
  b Switch to start condenser fan
  c Select the evaporator fan motor blower to start
  d Select the compressor motor/cooling mode on display panel to start.
  e For checking/setting temperature, select temperature set button
- Check phase current by separate ammeter
- Set safely cut out in microprocessor controls panel.

— — — — — — — —

TASK 5 : **Record sheet**

Fill up the specifications/details of the components and controls in the record sheet given at the end of this exercise.

Fig 1



MICROPROCESSOR DISPLAY PANEL

Split package A/C unit

1 Make/mode :

2 Type of unit :

3 Capacity :

4 Refrigerant used :

5 Compressor Mark :

6 Compressor model/Type:

7 Compressor power (KW) :

8 Filter type :

9 Electric supply : _______ PH, _______ V, ________ Hz

10 Evaporator blower motor : ____________KW

11 Fan capacity : __________cu/m per hour/ (cfm)

12 Speed (rpm) : ____________rpm.

13 Base weight (kg) : __________

— — — — — — — —

Electrical circuit of split package AC

Objectives: At the end of this exercise you shall be able to
- **check and Test various electrical components through a diagnostic**
- **trace the wiring circuit of split package A/C.**

Requirements

Tools/Instruments

• Screw driver 100 mm long	- 1 No
• Line tester	- 1 No
• Multimeter	- 1 No
• Clamp meter	- 1 No
• Voltmeter	- 1 No

Equipment

- Split package unit electrical wiring circuit

Materials

- Insulation tape -1roll

PROCEDURE

TASK 1 : **Trace the wiring circuit of split package A/C**

1 Trace the wiring circuit in fig 1 (or follow manual)

2 Insulate the wires if it in necessary

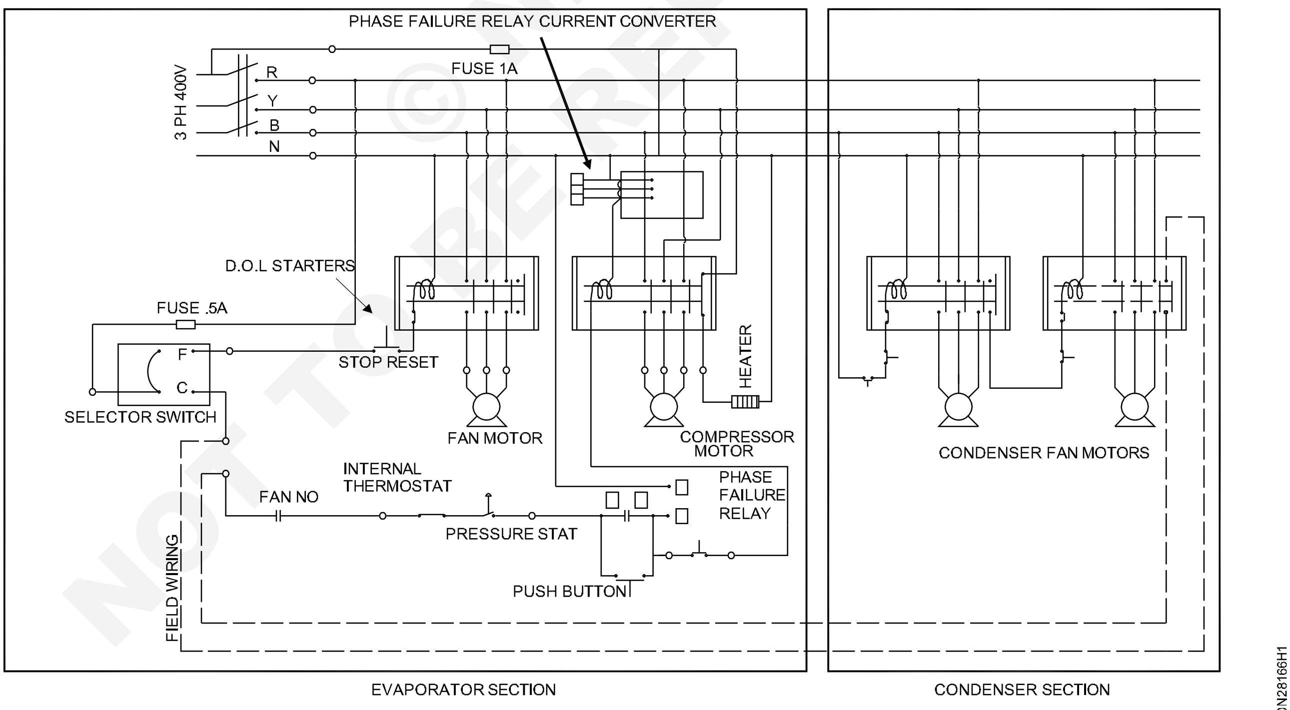
3 Check and clean the electrical contact points

4 Tighten any loose connection found

5 Check for the unit must be grounded

6 Use copper conductors for supply connections.

Fig 1



AC WIRING

— — — — — — — —

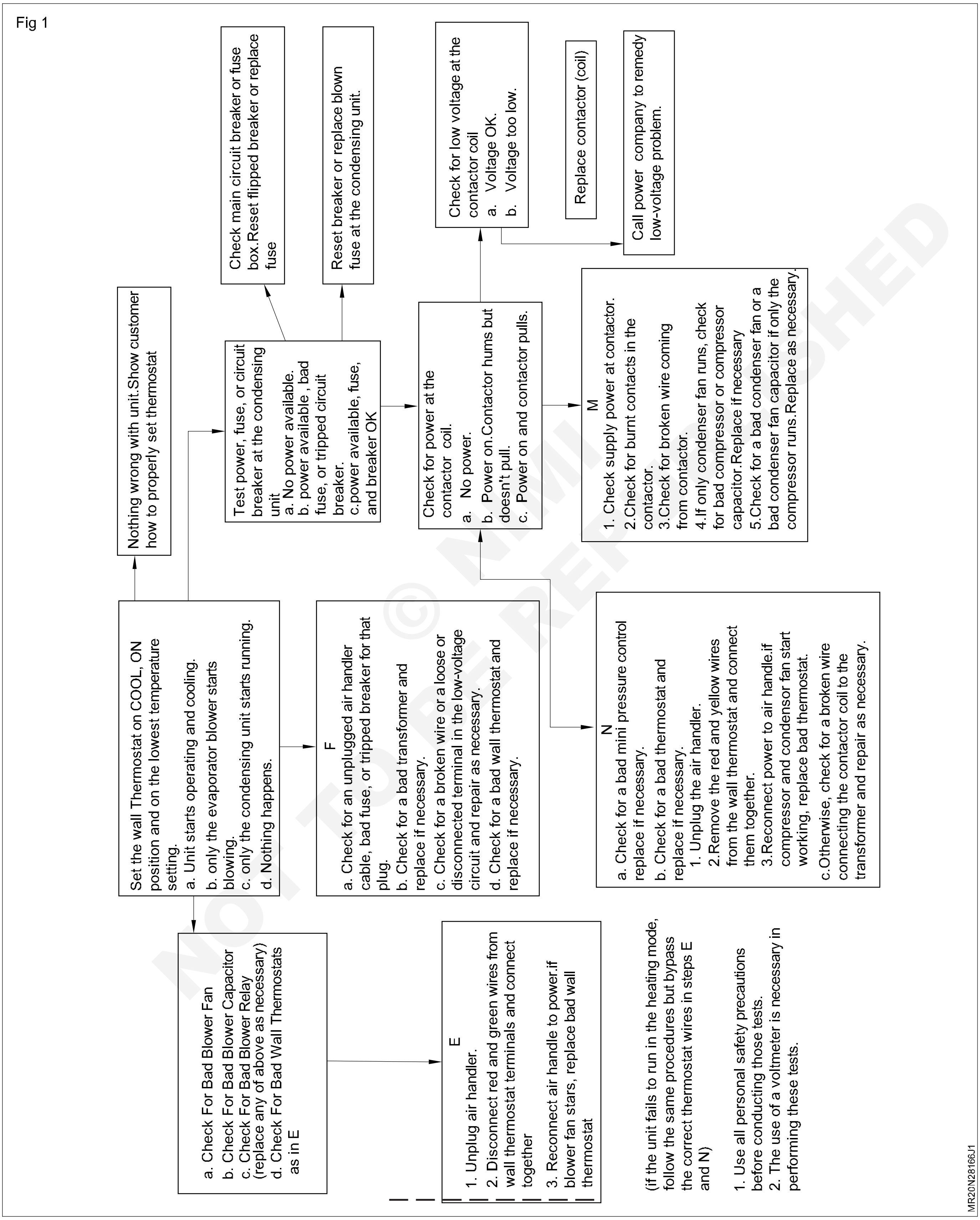
TASK 2 : **Check the electrical compounds through diagnostic chart.**

1 Perform an electrical diagnostic of the electrical components as per the chart.

2 Rectify any fault found following the remedial steps.

An electrical diagnostic chart for a split system package air conditioner in the cooling mode

Fig 1



Identify various component of central A/C plant

Objectives: At the end of this exercise you shall be able to
- **identify the electrical components**
- **identify the mechanical components**
- **identify the different flow cycle.**

Requirements

Tools/Instruments

- Double end spanner set - 1 Set
- Adjustable wrench 200mm - 1 No.
- Screw driver 200 mm - 1 No.

Equipment/Machines

- 5 TR central AC plant

PROCEDURE

TASK 1 : **Identify the electrical components**

1 Trace the electrical component located in the system.

2 Identify the electrical component one by one and enter in to tabular column and write function of each component.

Sl No.	Name of the Component / Control	Function
1		
2		
3		
4		
5		
6		
7		
8		

— — — — — — — —

TASK 2 : **Identify the mechanical components**

1 Locate the mechanical components of the central A.C plant.

2 Identify the mechanical components one by one.

3 Note the components and enter in to tabular column and write its function.

Sl No.	Name of the Mechanical parts	Function
1		
2		
3		
4		
5		
6		
7		
8		

— — — — — — — —

TASK 3 : **Identify the different flow cycles**

1 Trace the Mechanical Components.

2 Identify the flow of refrigerant in the system.

3 Trace the condenser water cycle.

4 Identify the flow of water from cooling tower to condenser and condenser to cooling tower.

5 Trace the AHU, return duct and supply duct.

6 Identify the flow of air from AHU to A.C Room to AHU with duct system.

— — — — — — — —

Electrical circuit of central A/C plant

Objectives: At the end of this exercise you shall be able to
- **identify the electrical components used in the circuit**
- **trace the wiring circuit of the plant.**

Requirements

Tools/Instruments

- Multi meter - 1 No.
- Screw driver 150mm insulated - 1 No.
- Insulated plier - 1 No.
- Voltmeter - 1 No.
- Test lamp - 1 No.
- Line tester - 1 No.
- Insulation tape - 1 No.

Equipment/Machines

- 5TR refrigeration plant. Direct system complete with all controls

Materials

- Water emery - as reqd.
- Banian cloth - as reqd.

PROCEDURE

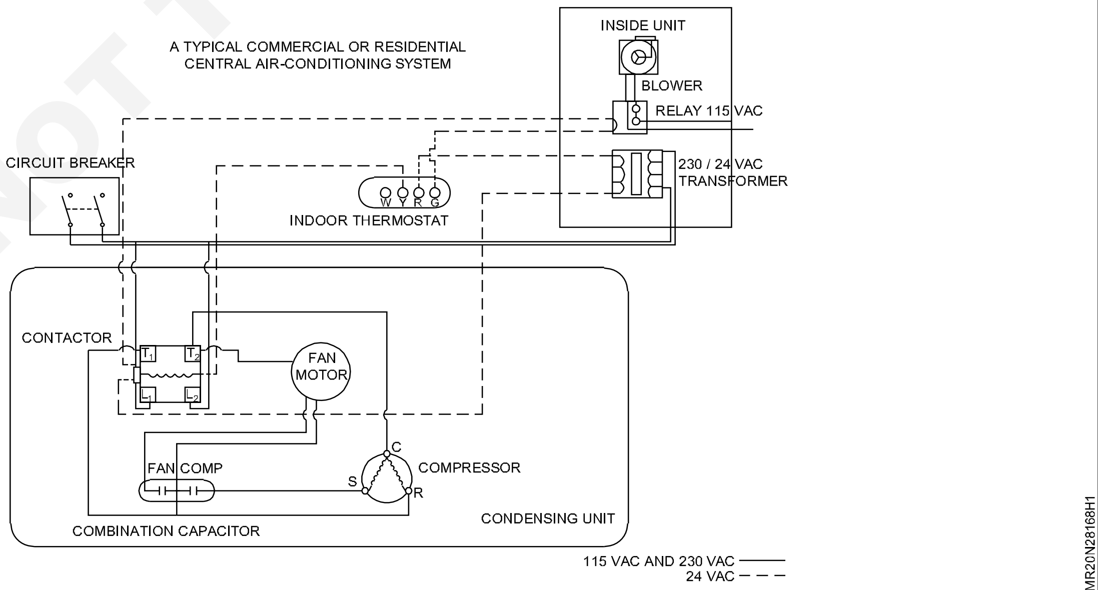
TASK 1: **Identify the electrical components of used in the circuit**

1 Identify the electrical components used in the circuit. like- a) Fuse unit b) Main MCB c) Motor contactors d) Overload relay e) Starters.

2 Record your identification with specification in the below provided table.

Sl.No.	Name of the Part identified	Specification / Function
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Fig 1



TASK 2 : **Trace the wiring circuit of the central A/C plant**

1 Trace the wiring circuit of a typical commercial or residential central A/C system as the figure 1 given below

2 Identify three phase motor protectors in the circuit see Fig 1 below.

Three phase - Protector

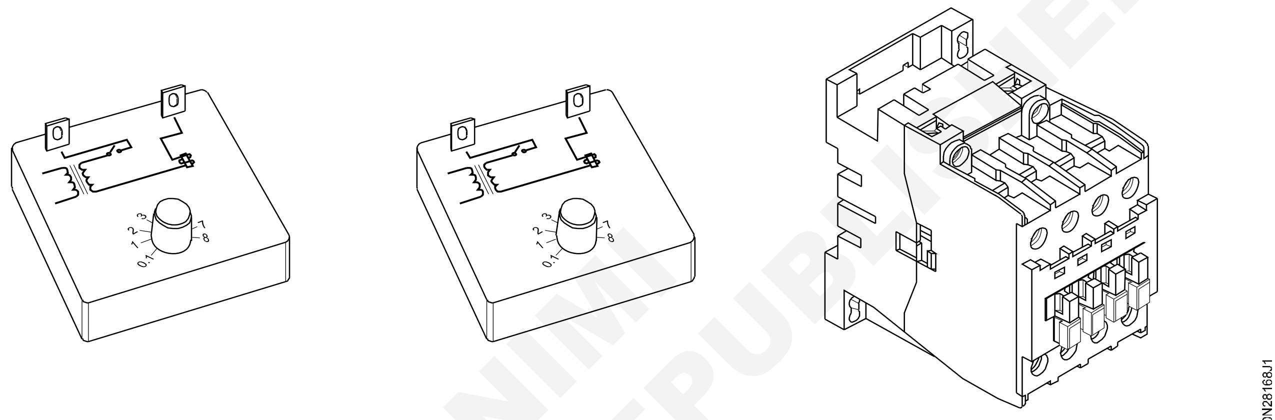
- Three-phase- motor protects the compressor by shutting off power to the unit in case of (a) energy surge, (b) low voltage, (c) phase loss, (d) phase imbalance, (e) phase reversal, or (f) short-cycling. It indicates the specific problem(s) and in which order they occurred. Six indicator lights display line status and faults in memory.

- Five -seconds-to-eight-minutes adjustable delay timer. After power interruption, time period start when power is restored and thermostat closes. The two terminals are connected in series with load.

- This timer will prevent short-cycling by delaying the start-up of a compressor for five minutes after a power interruption. Its terminals are connected in series with the load.

- Different styles of bayonet-type relays for solid-state circuit boards. They are widely used in ice machines.

Fig 1



THREE PHASE-PROTECTOR

— — — — — — — —

Service AHU and fire dampers

Objectives: At the end of this exercise you shall be able to
- **service various components of AHU/Air washer**
- **service fire dampers.**

Requirements

Tools/Instruments

- Double end spanner 6mm to 17mm - 1 Set.
- Screw drive 6” - 1 No.
- Descaling pump set - 1 Set.
- Gasket cutting - 1 Set.
- Moderate heating source - 1 No.

Equipment/Machines

- Electric Humidifier
- Steam Humidifier, Electric Humidifier duct type

Material

- Goggles, Mouth mask - 1 Set
- 15.00 mm PVC flexible hose - 3 Nos.
- 15 x 6 mm Brass or M.S nozzle - 1 No.
- Tap - 1 No.
- PVC Adopter for tap to hose - 1 No.
- 20 micron washable air filter - 1 No.
- Hydrochloric Acid - as reqd.
- Plastic bucket 20 Lts, Face shield - 1 No.
- Apron PVC - 1 No.

PROCEDURE

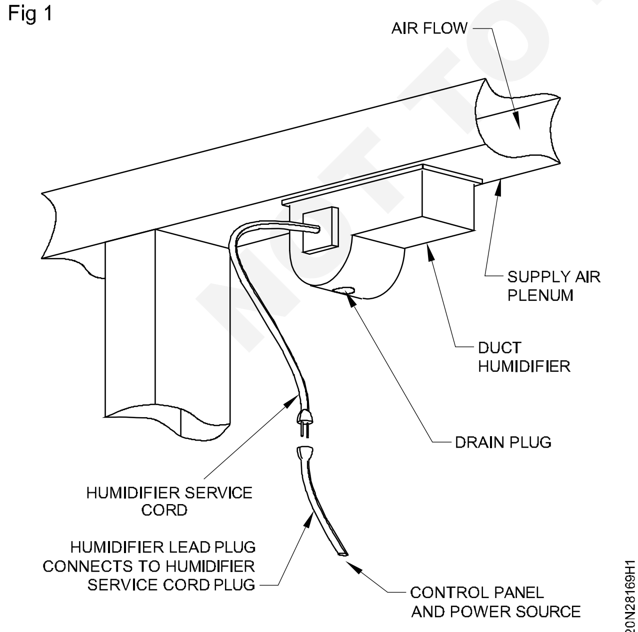
TASK 1 : **Service various components of AHU/Air washer**

Duct Humidifier

1 Ensure that the water valve to the humidifier is opened.

> **The humidifier can be opened only when the fan motor operates (check that the is on)**
>
> **A humidistat directly controls the operation of the humidifier. If humidity is high enough, the humidistat shuts down the humidifier, even when the fan motor is operating. (Fig 1)**

Fig 1



DUCT HUMIDIFIER

2 Clean the water - absorbing discs in the humidifier need clean periodically, as indicated in the manufacturer’s instructions.

3 Make certain that the humidifier water supply is on, that the humidifier is set properly, and that the humidifier discs are clean

4 Ensure that all the above point is OK. If anyone fails

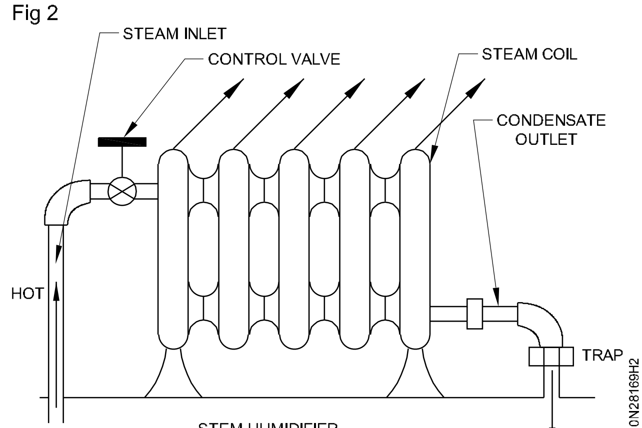
5 Check the manufactures manual and rectify the problem.

Steam Humidifier

1 Check that the main inlet steam valve is opened

2 Ensure that main control valve is operational. Fig.2.

Fig 2



STEM HUMIDIFIER

3 Check that the condensate outlet stop valve is opened

4 Check that the trap is functioning (only condensate water should drain from the trap not steam)

5 Check that main air blower is in operation

6 Check for any failure of the above mentioned operating conditions

7 Refer manufacturers manual and rectify.

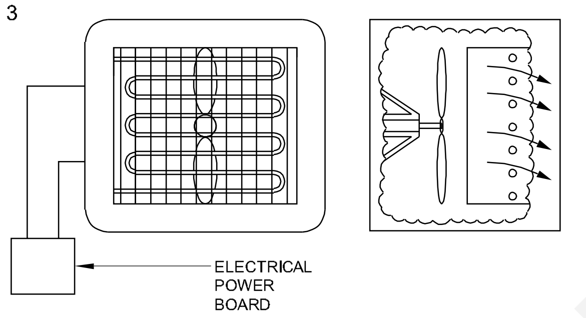
Electric heating in Air washer

1 Check that the power supply is on (indication lamp should glow)

2 Check that the main fan is in operation

3 Clean all the heating coil fins without restricting the air flow. Fig.3.

Fig 3



ELECTRIC HEATING IN AIR WASHER

4 Check the manufacturers manual and rectify for any abnormalities.

Dehumidifying Air washer

The common types of air washer used for cooling and dehumidification Fig.4.

The water which is sprayed is chilled in the evaporator of the refrigeration plant

1 Measure the temperature of the water which should be below the dew point temperature of the air

2 Check whether the chilled water pump should be in continuous operation

3 Ensure that the nozzles are not blocked

4 If the nozzles are blocked with foreign particles then stop the refrigeration plant and air washer fan and nozzles to be cleaned manually

5 Ref manufactures manual and rectify for any other failure.

Cleaning of air filter with water spray.

1 Take air flow reading and record it in the record sheet.

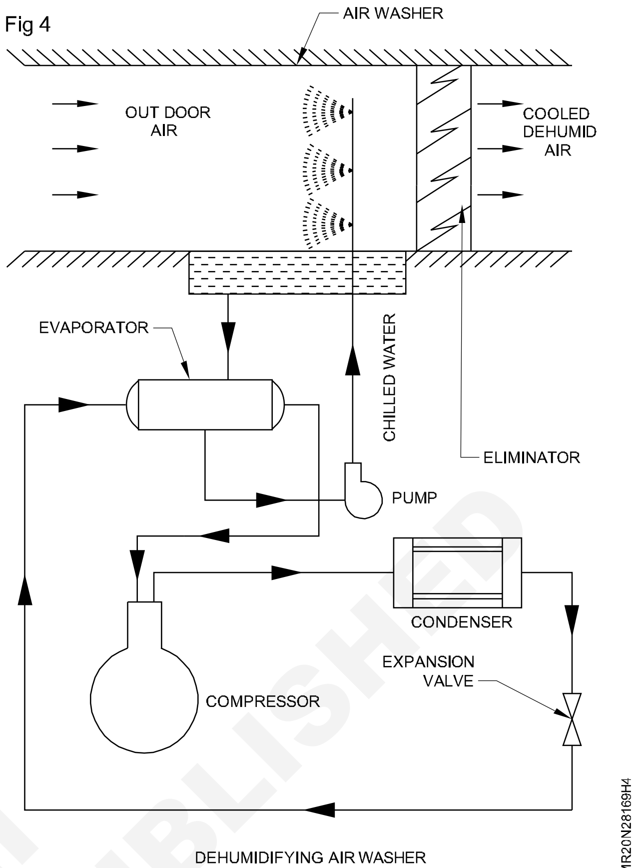
2 Remove filter from the equipment.

3 Hold it in front of a light or even sunlight.

4 See through the filter light should be visible.

5 Light not visible

Fig 4



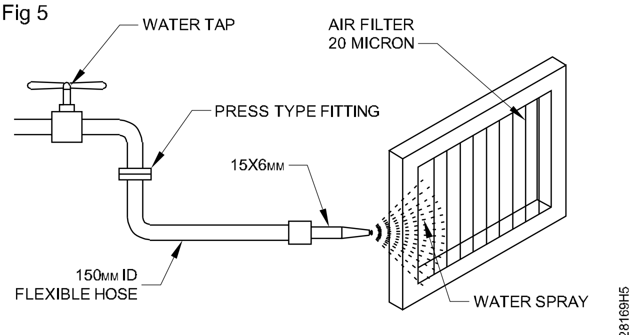
DEHUMIDIFYING AIR WASHER

6 Take the filter to open space and tap filter to the ground (wear goggles and mouth mask) to remove all the course duct.

7 Take the filter to washing area and rest against wall (inclined)

8 Fix flexible hose to water tap as shown in Fig 5.

Fig 5



AIR FILTER CLEANING WITH WATER SPRAY

9 Open tap and move nozzles up and down repeat this up and down to every pleat nozzles should be 25.0mm away from filter element.

10 Allow all the water to drain.

11 Hold the filter by hand and swing so that the water will drain fully.

12 Fix filter in position of equipment.

The same exercise to be repeated for all the filters in the equipment.

13 Start the unit and check the air flow with the help of velometer and record in Record sheet.

Precaution

1 Read filter catalogue supplied by manufacturer

2 Some of the filters are disposal so go as per the advice of filter supplier.

Cleaning of chilled water coil fins

1 Check if required air flow is up to the design quantity, after cleaning the air filter. If not follow the steps below.

2 Isolate the chilled water inlet and outlet valves.

3 Loosen the chilled water coil inlet flange bolts allow the coil water to drain.

4 Drain the water and loosen out flange bolts.

5 Remove all inlet and outlet flange to bolts and keep in tray.

6 Remove coil from equipment and shift to cleaning area.

7 Keep the air inlet side of coil.

8 Take 5% hydrochloric acid and pour on coil fins evenly.

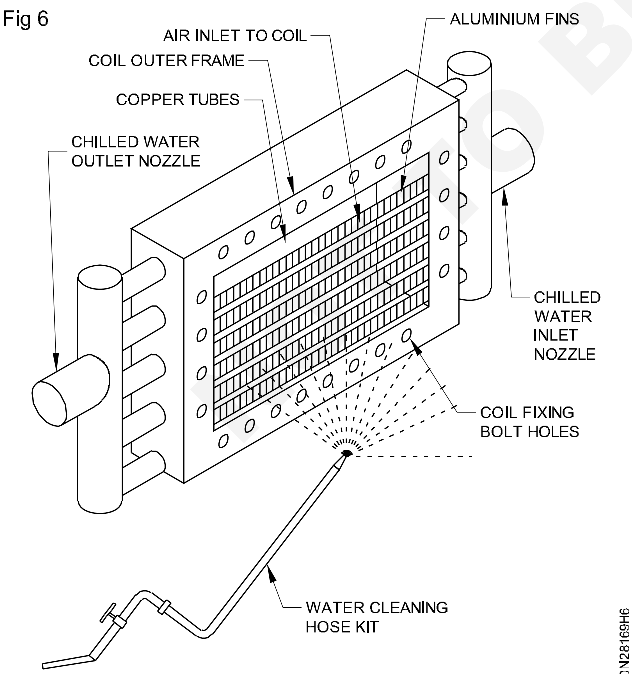
9 Wait for 30 minutes.

10 After 30 minutes lift the coil upright and keep the hydrochloric acid side facing front keep the coil inclined.

12 With the use of the water jet as shown in Fig 6. Spray the water as explained for cleaning of Air-filter. The water should be sprayed so that the complete force area to be cleaned.

13 Allow the water to drain.

Fig 6



CLEANING OF CHILLED WATER COIL FINS

14 Check the coil if it is cleaned fully by placing torch light behind the fins end light should be seen fully on the face (Air inlet Area)

15 After checking fix back the coil to equipment tighten all bolt & nuts.

16 Connect all water lines.

17 Open the water valves check for leaks.

18 Start A.H.U. (equipment) and take air flow readings and check recommended readings with of manufacturer.

19 Also check the temperature drop in Air across the coil.

20 Record all the reading in record sheet.

Safety precautions

1 While handling Hydrochloric acid

  a Wear PVC gloves

  b Face shield

  c Apron

Descaling of coil tubes, refer Ex.285.

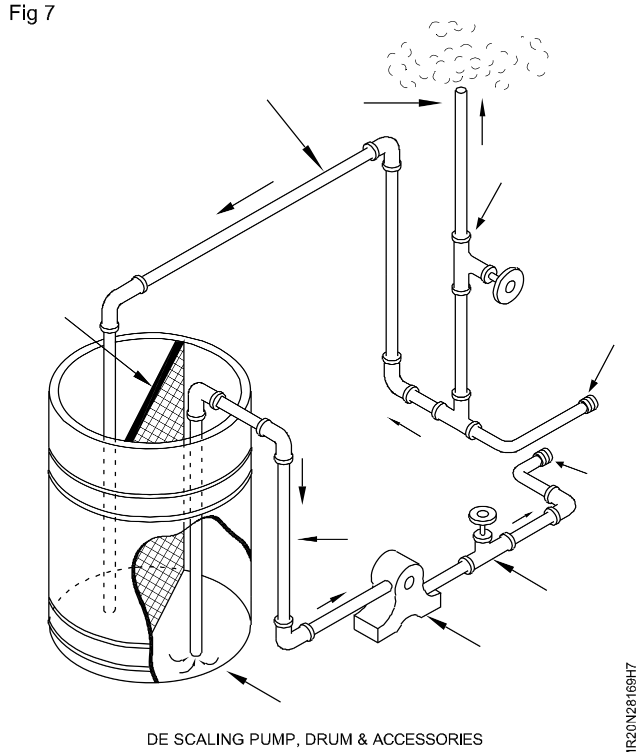
6 Stop the acid pump, add more water to dilute the acid in container then drain the drum through long flexible PVC hose to the drainage connection

7 Fill the fresh water to the drum, circulate around 15 minutes through the coils, when drain the water take sample and check with litmus paper for acidity.

8 Re--wash with fresh water till you get the water PH to 7.5 to assume, there is no acid stayed inside the coil

9 Remove the acid circulation pump, accessories and connect the chilled water coil to the system.

Fig 7



DE SCALING PUMP, DRUM & ACCESSORIES

Record sheet

Table 1

Grill No.	Air flow reading		Total Air flow
	Before cleaning filter	After cleaning filter	
1			
2			
3			

Table 2

Grill No.	Air flow reading Before cleaning coil		Air flow reading After cleaning coil	
	Before air Temp.	After air Temp.	Before air Temp.	After air Temp.
1				
2				
3				

— — — — — — — —

TASK 9 : **Method of de-scale Air-washer**

1 Follow the steps as per sequence to prepare the air-washer for de-scale

2 Remove the spray nozzles at the ends of the chilled water coils (lines) inside the cabinet.

3 Drain the water in the basin and clean the basin with G.I. plate and wire brush, use bleaching power and wash the basin with fresh water

4 Clean the nozzle's holes with scriber and rinse, change the damage or worn out nozzle's

5 Repeat the de-scale process

6 Fit the spray nozzles at the proper places.

— — — — — — — —

TASK 10 : **Final check and put in operation**

1 Open chilled water line inlet & outlet, start the chilled water pump circulation and release the air-lock

2 Check if there is any leak in the flange joints, if it is so, tighten properly.

3 Check it sprays properly in all the spray nozzles (at air washer)

4 Stop the circulation pump and close the cabinets side doors air-tight

5 Start the plant as per sequence and check the reading after 1 hour

6 Check the chilled water pressure inlet & outlet to recommended level

7 Check the improvement in cooling effect, compare to previous reading in room temperature

Make ready to de-scale the AHU (chilled water coil)

1 Get the clearance from instructor and stop the plant

2 Switch 'off' the water circulating pumps, fans and close the chilled water inlet & outlet to AHU

3 Isolate the panel board main switch and keep the unit 'under maintenance' board

4 Open the AHU cabinets side door for chilled water coil

5 Open both inlet & outlet of the chilled water line's flanges and drain the remaining chilled water inside

6 Dilute the HCL to required quantity and keep in the drum or barrel, which is to use for circulation

7 Prepare rubber gaskets for the flange joints or make permanent gaskets to the requirement.

De-scale the chilled water coil at AHU

1 Connect acid circulation pump's inlet to the container (Ref. Fig 1 of Exercise no.746)

2 Connect the acid pump's outlet to the outlet of the chilled water coil

3 Connect a line to chilled water coil inlet, with vent line in between from the top of the container

4 Tighten every joints leak proof with gaskets, then start the acid pump now release the air-lock through vent pipe

5 Leave it to run for 1 or 2 hours and stop the acid pump

If the diluted acid became too contaminated with sediments, change the acid again, interchange the connections as chilled water coil inlet to acid pumps delivery and the chilled water coil outlet to container and run the pump for 1hr.

— — — — — — — —

TASK 11 : **Checking and servicing of fire dampers**

Maintenance

1 Check actuator and tighten linkage if necessary

2 Clean damper blades and other working parts if necessary

3 Lubricate linkage, bearings and other moveable parts with a silicon lubricant

4 Do not use petroleum based products as they could cause excessive dust collection

5 Operate the damper via actuator

6 Check the blades to make sure they completely close and re-open

Testing of fire dampers

1 Use a moderate heat source and heat the thermal disc found "in the air stream" on the fire damper

Caution: Too much heat may damage the thermal disc

2 Observe if the damper blades are getting closed by the heat as the disc will dimple and cause the flow of electricity to the actuator to stop

3 Allow the disc to cool

4 Press the reset button on the outside of the damper. Flow of electricity to the actuator will resume and the damper blades will open up

Note

- **If possible, operate the dampers under normal airflow conditions.**
- **Fire dampers are also known as smoke dampers.**

Record sheet

Table 1

Reading before de-scaling the chilled water coil.

Chilled water				Room
Pressure		Temperature		Temperature
Inlet	Outlet	Inlet	Outlet	

Table 2

Reading after de-scaling the water coil.

Chilled water				Room
Pressure		Temperature		Temperature
Inlet	Outlet	Inlet	Outlet	

Rinsed water P.H. (After de-scaling) =

Total no.of spray nozzles (Air-washer) =

No.of nozzles changed =

Remarks :

Trainee : Instructor :

Check air flow, dampers, temperature and pressure

Objectives: At the end of this exercise you shall be able to
- **check the air-flow distribution**
- **check the dampers**
- **measure temperature and pressure.**

Requirements

Tools/ Instruments

• Philips screw driver	- 1 Set.
• Screw driver, 3mm tip, length 100mm	- 1 No.
• Scriber, Divider	- 1 No.
• Hammer, nylon 300 gms	- 1 No.
• Hammer ball pein 220 gms	- 1 No.
• Pliers flat nose length 150 mm	- 1 No.
• Plier long nose length 200 mm	- 1 No.
• Sheet metal sniper 200 mm	- 1 No.
• Center punch 150 mm	- 1 No.
• Hand drilling machine with 6 mm drill bit	- 1 Set.
• Drill bit, Scissors	- 1 Set.
• Jumper, Thermometer (digital)	- 1 No.
• Knife, Folded S.S. 150 mm	- 1 No.
• Pop rivet gun, Anemometer	- 1 No.

Equipment/Machines

- 5TR Air-conditioning plant equipped with AHU or air-washer and complete duct system

Materials

• Insulation & duct materials	- as reqd.
• Engg. Rule 300 mm long	- 1 No.
• Measuring tape 10m & 2m graduation	- 1 No
• Pencil, Marker pen	- 1 No.
• Marker pen	- 1 No.
• Self thread screw, bolts & nuts	- as reqd.
• Hanging clamp supports (wooden blocks)	
• Ladder, Velometer	- 1 No.
• Goggles, Mouth mask, Rubber pads	- 1 No.
• Gaskets for duct joints	- as reqd.
• Canvas & insulation converging cloth	- as reqd.

PROCEDURE

TASK 1 : **Check the air flow distribution**

1 Start the air-conditioner plant and AHU

2 Wait till the plant to stabilize, then check the air velocity in supply and returns ducts

3 Check, if any dampers are closed, open it.

4 Check the air velocity by various drills or diffusers and record

5 Compare it with manufacturer's manual and find any loss in air velocity

6 Check and confirm the air velocity loss is not because of the fan problem

— — — — — — — —

TASK 2 : **Checking of damper (Fig 1)**

1 Check power or open or power closed

2 Check frequency

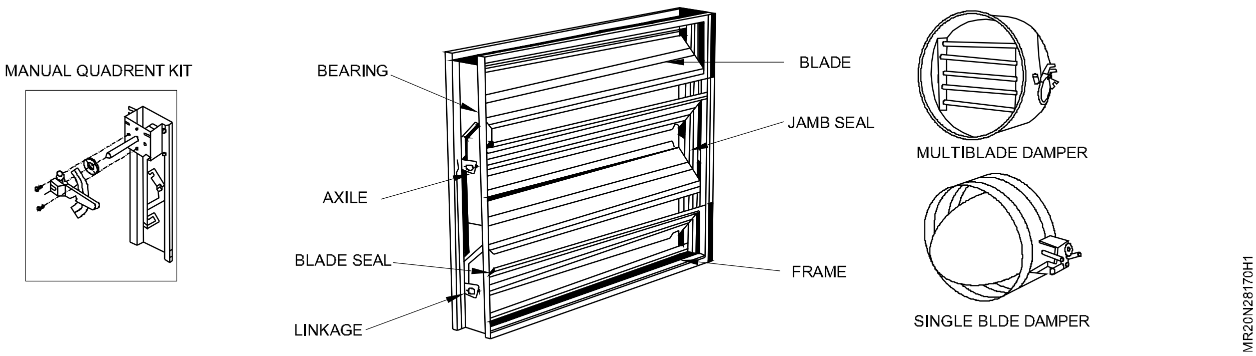
3 Check spring return of drive damper

4 Check floating damper

5 Check automatic smooth flow of air as per design data

— — — — — — — —

Fig 1



TASK 3 : **Measure the pressure and temperature**

1 Identify the compound pressure and oil pressure gauge connected in the system

2 Note the suction pressure shown in compound gauge and entered into the tabular column

3 Measure the head pressure shown in pressure gauge and entered into tabular column

4 Measure the oil pressure shown in oil pressure gauge and entered into tabular column

5 Measure the temperature shown in thermometer and entered into tabular column

Sl.No	Data	Value
1	Suction pressure	
2	Discharge pressure	
3	Oil pressure	
4	Temperature	

Pump down gas from central A/C plant

Objectives: At the end of this exercise you shall be able to
- **pump down the compressor**
- **pump down the system.**

Requirements

Tools/ Instruments

• Valve key (handle)	- 1 No.
• Double end spanner set	- 1 No.

Equipment/Machines

• Compound gauge, pressure gauge attached to operating panel	- 1 Set.

Materials

• Commercial open type compressor system	-1 Set.
• Clean cloth	- as reqd.
• Match box	- 1 No.
• Soap solution in a vessel with brush	- 1 Set.

PROCEDURE

TASK 1 : **Pump down the compressor**

1 Ensure the plant is idle, if it is running, with the instruction of instructor.

2 Put off the system.

3 Close the suction (service) isolating valve.

4 By pass the electrical connection at low pressure cut-out switch.

5 Watch and wait till the suction pressure drops to 0.5 kg./sq.cm.

6 Stop the compressor- drive motor

7 Immediately close the delivery (discharge) valve.

8 Open the suction gauge port and vent the least gas pressure from the compressor

Precaution : Do not allow the compressor suction pressure drop to vacuum, or allow oil to pump to the system.

TASK 2 : **Pump down the system**

1 Put off the system, if it is running.

2 Bypass the electrical connection at the low pressure cutout switch.

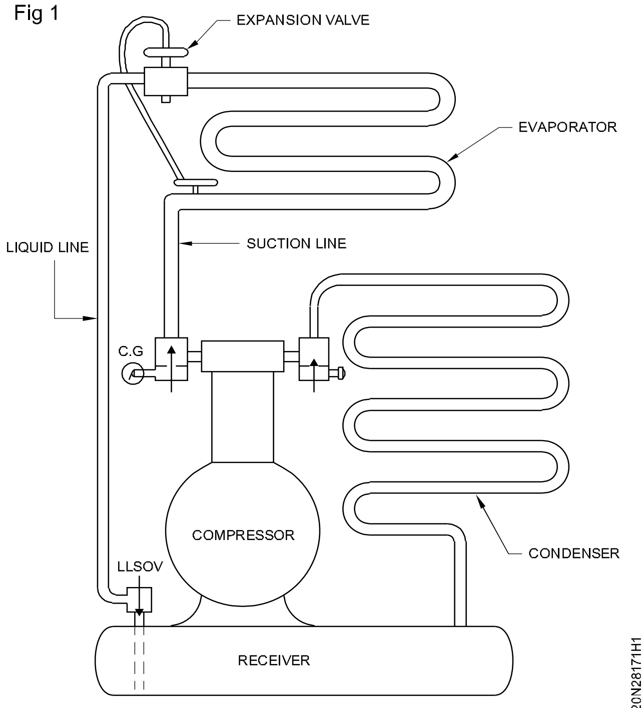
3 Close the (King valve) liquid line shut off valve.

4 Start the compressor and watch the suction valve gauge pressure drop till 0.5 kg/sq.cm.

5 Stop the compressor and close the discharge valve. Refer Fig.1 Transferring refrigerant to the receiver.

Precaution : Ensure the water flow in the water cooled condenser.

Fig 1



TRANSFERING REFRIGERANT TO THE RECEIVER

Top up gas to the central AC system

Objectives: At the end of this exercise you shall be able to
- **check the system**
- **determine the need**
- **top up the central A/C.**

PROCEDURE

TASK 1 : **Check the system**

1 Perform standard maintenance on the system clean evaporator, condenser, air filter. If any of the above are dirty it causes symptoms similar to a unit that is low on refrigerant.

2 Check for any obstructions, including buildup of debris on the air handler blower fan and make sure the condenser fan is operating correctly.

3 Conduct a through inspection of the rest of the components of the system. Like- Missing insulation, like ductwork joints, poor electrical connection etc.

— — — — — — — —

TASK 2 : **Determine the need of the system**

1 Determine the type of refrigerant need for the central A/C. Check the label on the unit's cabinet for manufacturer's specifications (R-22 or R410A).

2 Determine what type of charging connections your system is equipped with.

3 Start and stop the unit using the thermostat.

4 Turn the power off by removing the fuses or by turning the breaker off before continuing.

5 Hook up the gauge manifold with the unit when A/C unit is off. The blue hose to the low pressure side and red hose to the high pressure side.

6 Turn on the A/C and wait 15 minutes for the system to stabilize with the gauge being hooked up.

7 Take the reading on the gauges. The blue gauge should have dropped it the system needs to be charged.

— — — — — — — —

TASK 3: **Top up gas to the central AC unit**

1 Shut down the AC unit

2 Attach the low pressure hose (blue) to the suction line and the high pressure hose (red) to the liquid line

3 Turn on the AC. Let it run for at least 15 minutes so that the system can reach steady state operation.

4 Check the outdoor air temperature, return air temperature, suction line temperature and note it.

5 Determine the metering device used in the system. if the system uses a TEV or restrictor orifice.

6 Pump down the system and pressure test nitrogen (300psig) in the system with soap solution check leakage in the system. If leak is found arrest the leak. Evacuate the system.

7 Charge the system by connecting the charging or supply hose from manifold to the refrigerant container.

8 Check the parameters for proper cooling.

9 Connect a new cylinder with the system, if the parameters are not found specific and there is a need to add refrigerant.

10 Introduce refrigerant into the suction line of the system, slowly and in small amounts.

11 Check pressure and temperature readings and determine if more refrigerant is needed.

12 Repeat until every parameters as per specifications looks normal.

13 Observe a complete cooling cycle.

14 Turn off the power to the unit and remove the gauges, after AC has completed a cycle.

> **NOTE : Do not tilt the refrigerant container, as this will introduce liquid refrigerant into the suction side of the compressor and can result in damage to the unit.**

— — — — — — — —

Check temperature and pressure control

Objectives: At the end of this exercise you shall be able to
- **check HP safety cutout**
- **check LP safety cutout**
- **check oil pressure safety cutout**
- **check and service electronic thermostat control.**

Requirements

Tools/Instruments

- Screw driver - 1 Set
- Double end spanner set - 1 Set
- Charging line - 2 Nos
- Pressure gauge 0 to 30 kg/cm^2 - 1 No.
- Pressure gauge 0 to 10 kg.cm^2 - 2 Nos.
- Adjustable wrench - 1 No.
- Valve key (handle) - 1 No.
- Thermometer (0-50ºC) - 1 No
- Thermometer (-50ºC to +50ºC) - 1 No.
- Ring spanner set - 1 No.
- Screw driver 150mm length - 1 No.
- 6” screw driver - 1 No.
- 6” adjustable spanner - 1 No.
- Hammer 450g ball peen - 1 No.
- Flaring tool, Tube cutter - 1 No.
- Continuity tester battery operated

Equipment/Machines

- High pressure safety cut out - 1 No.
- Oil pressure safety cut out - 1 No.
- Air-conditioning system with water cooled condenser provided with water regulating valve and water flow
- Thermometer (digital) meter
- Heat exchanger
- 0-10 kg. low pressure switch bellow type
- Thermostatic expansion valve - 1 No.

Materials

- 6.0mm copper tube as per length - as reqd.
- 6.0mm flare nut - 8 Nos.
- 6.0mm equal flare tee - 2 Nos.
- Clean cloth - as reqd.
- Goggles - 1 Pair
- Oil can - 1 No.
- Hydraulic hand pump
- Nitrogen cylinder, line with
- two way regulator and gauges
- Rubber hose with jet arrangement
- Soap solution with small container

PROCEDURE

TASK 1 : **Check high pressure safety cut out (Fig 1)**

1 Keep nitrogen cylinder regulators in closed position by keeping the handle fully loose.

2 Open the nitrogen cylinder valve with the valve key.

3 Check the cylinder pressure on the dial in Gauge 1.

4 Connect the charging hose to the pressure switch as shown in Fig 1.

5 Watch the movement of the spring and place the continuity tester leads on the terminal across No & terminals, the light should not glow. This indicates the switch has cut out.

— — — — — — — —

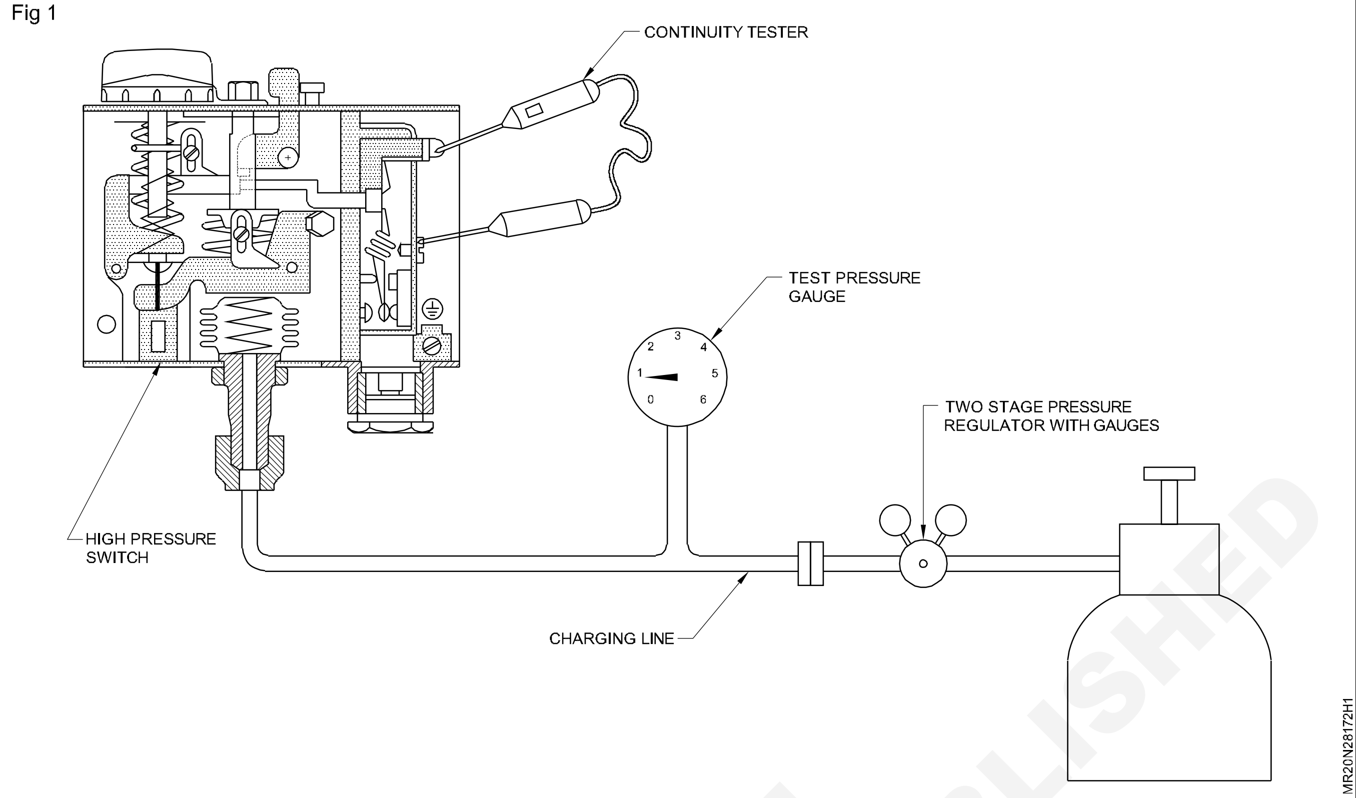
TASK 2 : **Check oil pressure safety cut out (Fig 2)**

1 Connect one nitrogen cylinder to the oil pressure bellows (element)

2 Connect the one more nitrogen cylinder to the crank-case bellows.

3 Open both the cylinder valves place the continuity tester probe on the leads of the switch. When oil pressure is set at mentioned above. The continuity test light should glow. This indicates that the switch is closed. Close the cylinder oil pressure charging cylinder, loosen the flare nut and drop the flare nut and drop the oil pressure to 2.0 kg. The contacts will open and the continuity tester light will not glow. This indicates that the switch is set OK.

Fig 1



TASK 3 : **Check the LP cutout switch**

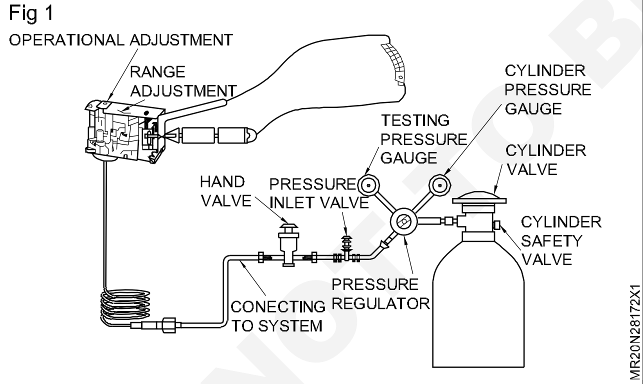
1 Set and test the bellow type - low pressure switch

2 Isolate the switch from power and gas connection

3 Remove the switch from location

4 Connect to nitrogen cylinder with two stage regulator as shown in Fig 1.

Fig 1



5 Set the cut out pressure at 2.0 Kg/cm^2 on switch cut out scale.

6 Open nitrogen cylinder by using the valve key and set the nitrogen pressure at 2.0 kg/cm^2 on the stage pressure regulator gauge. No. 2.

7 Check the switch if it has cutout, by placing the continuity tester on the load.

8 The bulb in the continuity tester should not glow.

9 Set cut in pressure at 3.0 kg. in differential scale. Increase the nitrogen pressure to 3.0 kg/cm^2 and

10 Place the continuity tester probes on the switch leads the light has to glow. This indicates that the switch contacts are closed.

11 Close nitrogen cylinder and disconnect the fittings from the switch.

12 Fix the switch lock plate and cover. Keep switch ready for use.

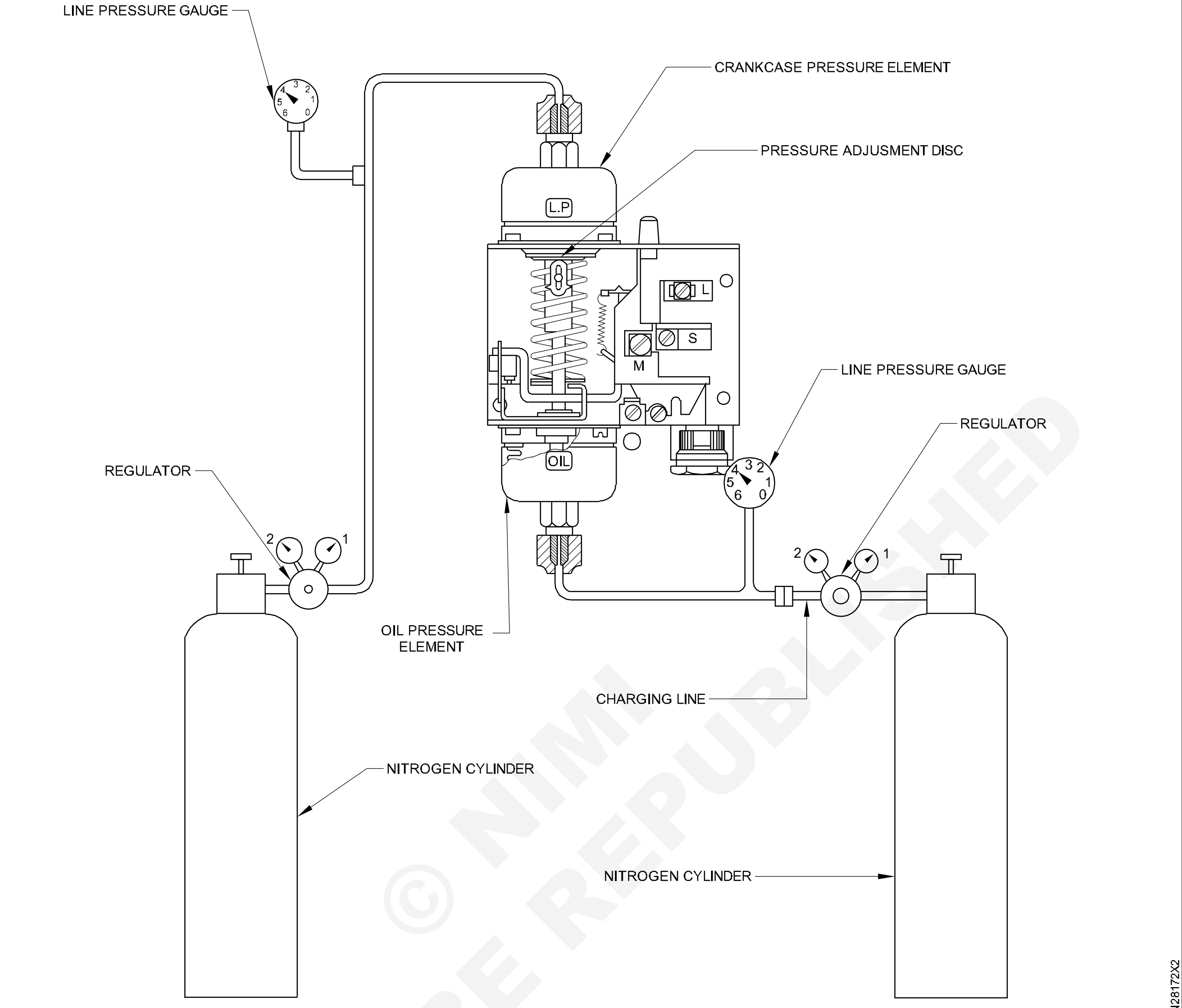
Service the electronic thermostat

1 As the electronic thermostat has no moving parts so the service is less.

2 Open the outer cover.

3 Clean the electronic circuit cord with soft brush. Refer manufacturers cleaning procedure and manual for operation.

Fig 2



OIL PRESSURE SWITCH TESTING METHOD

Identify various components of direct expansion type central A/C plants

Objectives: At the end of this exercise you shall be able to
- **identify the electrical components**
- **identify the mechanical components**
- **identify the different flow cycle.**

Requirements

Tools/Instruments

- Double end spanner set - 1 Set
- Adjustable wrench 200mm - 1 No.
- Screw driver 200 mm - 1 No.

Equipment/Machines

- 5 TR central AC plant

PROCEDURE

TASK 1 : **Identify the electrical components**

1 Trace the electrical component located in the system.

2 Identify the electrical component one by one and enter in to tabular column and write function of each component.

Sl.No	Name of the Component/Control	Function
1		
2		
3		
4		
5		
6		
7		
8		

_ _ _ _ _ _ _ _

TASK 2 : **Identify the mechanical components**

1 Locate the mechanical component on the central A.C plant.

2 Identify the mechanical component one by one.

3 Note the component and enter in to tabular column and write its function.

_ _ _ _ _ _ _ _

TASK 3 : **Identify the different flow cycles**

1 Trace the Mechanical Component.

2 Identify the flow of refrigerant in the system.

3 Trace the condenser water cycle.

4 Identify the flow of water from cooling tower to condenser and condenser to cooling tower.

5 Trace the AHU, Return duct and supply duct.

6 Identify the flow of air from AHU to Air Conditioning Room and A.C Room to AHU with duct system.

Sl.No	Name of the Mechanical Parts	Function
1		
2		
3		
4		
5		
6		
7		
8		

_ _ _ _ _ _ _ _

Electrical circuit of direct expansion type central A/C plant

Objectives: At the end of this exercise you shall be able to
- **identify the wiring circuit of the plant**
- **check and test the components of the circuit**
- **trace the wiring circuit.**

Requirements

Tools/Instruments

- Multi meter - 1 No.
- Screw driver 150mm insulated - 1 No.
- Insulated plier - 1 No.
- Voltmeter - 1 No.
- Test lamp - 1 No.
- Tester (line) - 1 No.
- Insulation tape - 1 No.

Equipment/Machines

- 5 TR Refrigeration plant direct and indirect system complete with all controls.

Materials

- Water emery - as reqd.
- Banian cloth - as reqd.

PROCEDURE

TASK 1: **Wiring circuit of the plant**

1 Check power circuit and control circuit

2 Identify the parts of the circuit

A Fuse unit B Main MCB C Motor contactors D Overload relay E Starters

— — — — — — — —

TASK 2: **Check and test components of the circuit**

Relays and starter are magnetically or electrically operated switches. Each device contains a magnetic coil and core or more sets of contacts. The individual set contacts may be N/O normally open or N/C normally closed. When the coil is energised.

1 Turn off all power to unit

2 Remove wires from relay coils

3 Check continuity across the terminals with multi meter.

If a very high resistance is indicated it is O.K.

4 Then place one meter probe to ground or to the unit frame and touch other probe to each coil terminal.

5 Replace the coil if a circuit is indicated from either terminal to ground.

6 Check coil voltage by voltmeter between coil wires after turning on unit power.

It should be the same voltage as indicated on the coil body.

7 Check that the contact should be normally open or closed. When the coil is de-energised or energised.

8 Turn off the power

9 Remove wire leading to the load or control device.

10 Check across each set of contacts by multi meter.

- **Normally open contacts should read infinite resistance.**
- **Normally closed contacts should read zero resistance.**

11 If an incorrect meter reading is obtained remove all wires leading to components.

12 Check again the contact points with multi meter and if the reading is still improper.

13 Check for welded or burnt contact.

14 Check for metal sploter carbonizing or mechanical jumping.

15 If possible repair or replace the contacts.

If component body, guide spring etc, shows signs of over heating reduce overall complete device.

16 Reassemble the starter properly, if contacts seem to be O.K.

17 Install the starter and connect properly.

18 Turn on unit power.

19 Determine the coil voltage by voltmeter.

20 Check voltage through contact terminals.

If incorrect voltage reading is observed the contacts are malfunctioning.

21 Check current drawn by motor.

22 Check for proper functioning of starter.

Precaution: At the time of disconnecting, wires should be marked as to reconnect correctly later.

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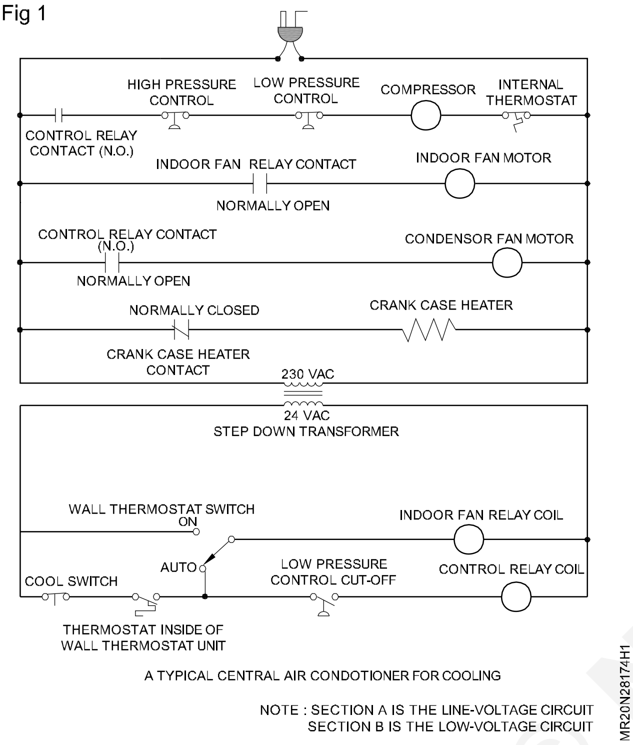
TASK 3: **Trace the electrical wiring of central A/C plant**

1 Trace the electrical circuit as per Fig 1

Fig 1



2 Check the installation manual for any other wiring circuit.

A central air conditioner with the thermostat on "Auto "position. A 230 VAC is decreased to 24 VAC to activate the indoor fan relay coil, which in turn activates the compressor, the internal fan motor and the condenser fan motor. In order for this to happen, the cool switch and thermostat must be closed. (Fig 2)

Heavy lines - wires encircled

Note the different paths in which the current travels in each of the diagrams.

When the thermostat switch in ON, the indoor fan relay coil is energized and activates the internal fan motor.

NOTE: The normally open (NO) contacts close, and the normally closed (NC) contacts open in the 220 VAC circuit when the control coil(s) is (are) energized in the 24 VAC circuits. (Fig 3)

Fig 2

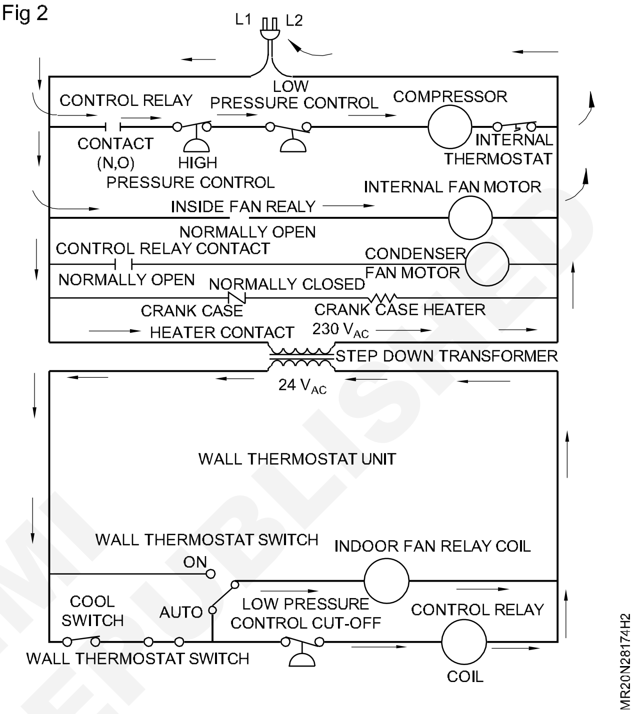
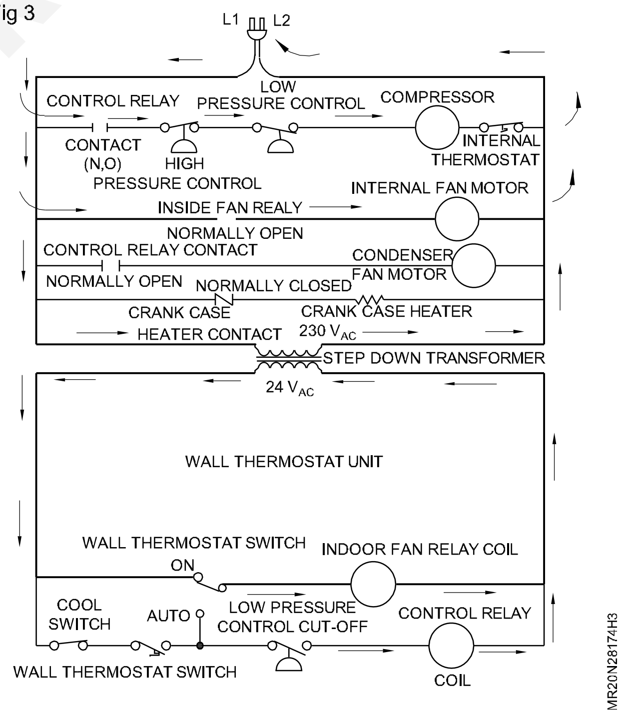


Fig 3



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Identify VRF/VRV system

Objectives: At the end of this exercise you shall be able to
- **identify the mechanical components of VRF/VRV system of ODU**
- **identify the electrical and electronic components of 1 the VRF/VRV system of ODU**
- **identify the mechanical, electrical and electronic components in IDU of VRV/VRF.**

Requirements

Tools/ Instruments

- Screw driver (150mm and 300mm) -1 No.each
- Double ended spanner - 1 No.
- Combination plier - 1 No.
- Adjustable wrench - 1 No.
- Air blower - 1 No.
- Ring spanner - 1 Set.

Equipment/Machines

- VRF/VRV air conditioning system -1 No.

Material

- L - allen key -1 Set.
- Box spanner -1 Set.

PROCEDURE

TASK 1 : **Identify the mechanical components of VRF/VRV system of ODU**

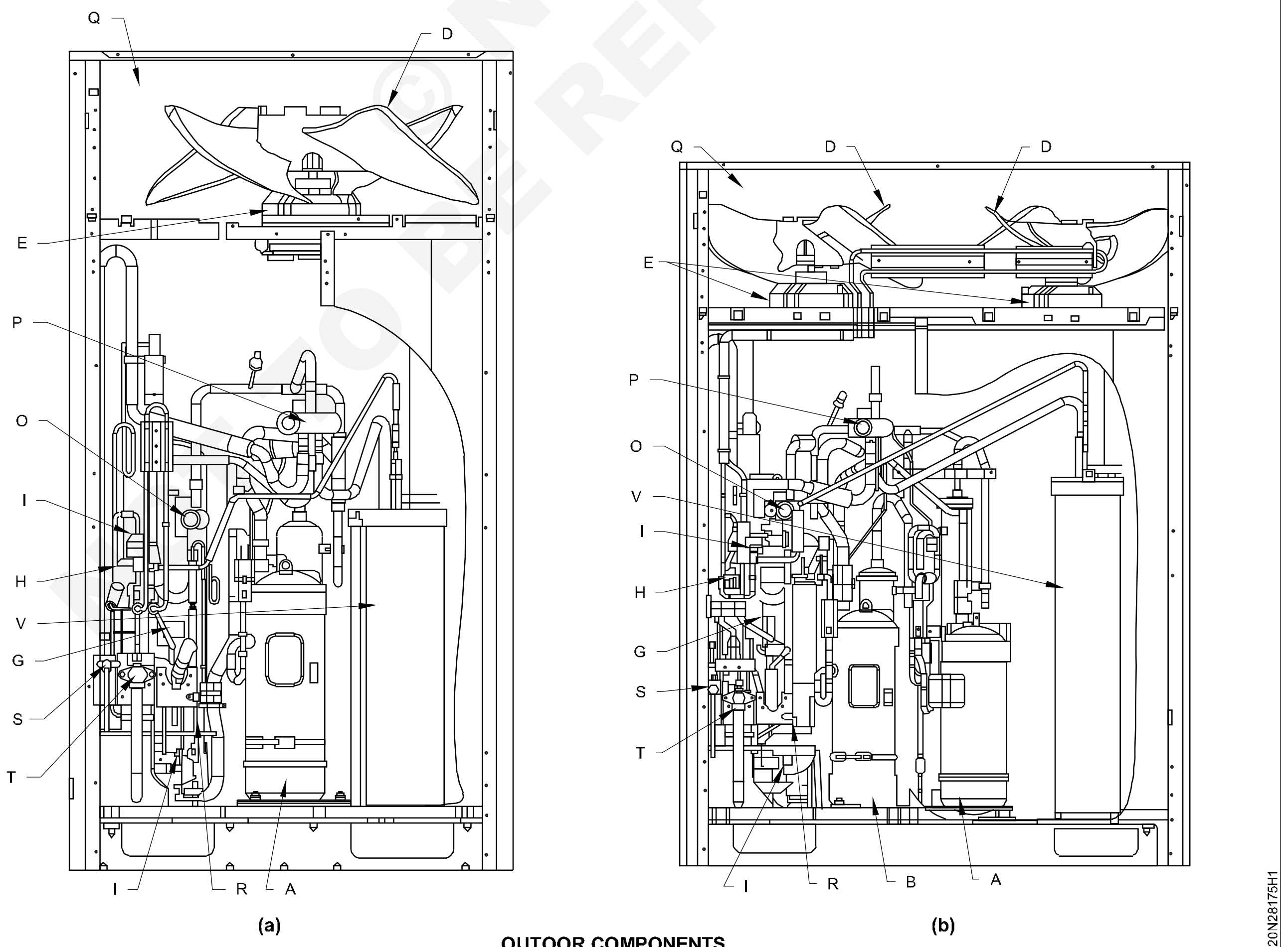
1 Bring the trainees to the AC system.

2 Locate the ODU of VRF/VRV.

3 "OFF" the system.

4 Open the front panel of ODU.

Fig 1



OUTOOR COMPONENTS

5 Trace the mechanical components of VRF system one by one, (Fig 1a & b).

6 Note the components, their specification, function, type and enter in the table provided.

Table 1 : Table of ODU and IDU mechanical components

Sl. No	Name of the component	Specification (as per manual)	Types	Function
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				

— — — — — — — —

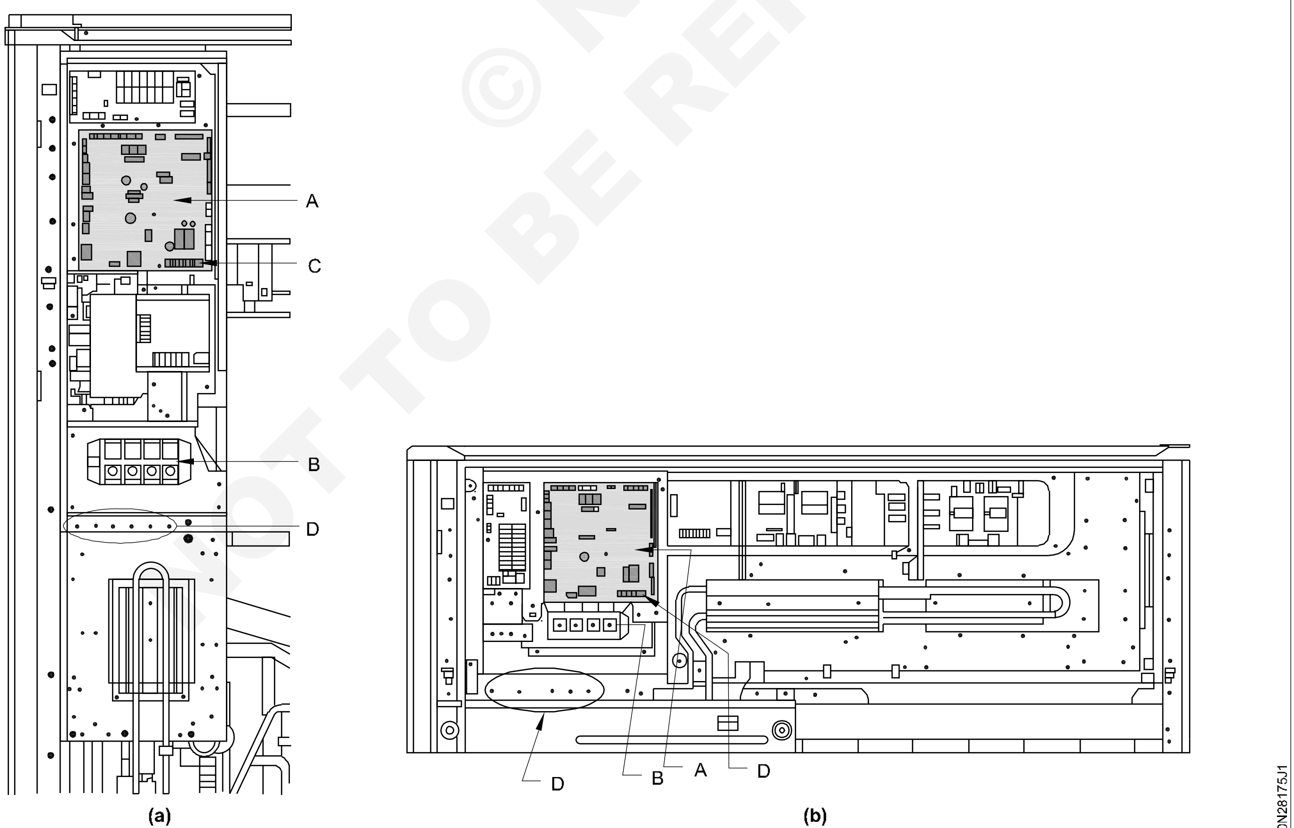
TASK 2: **Identify the electrical and electronic components used in VRV/VRF system of ODU**

1 Trace electrical components and identify one by one.

2 Note the electrical components with specifications and function in the table. (Fig 1 a & b)

3 Note the electronic components and enter with specifications and function in the table.

Fig 1



ELECTRIC CONTROL BOX (ODU) AND COMPONENTS FOR (8-12 HP AND 14-20 HP)

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TASK 3: **Identify the mechanical, electrical and electronic components of IDU of VRV/VRF system**

1 Locate the IDU.

2 Open carefully the front panel of IDU.

3 Identify mechanical, electrical and electronics components.

4 Note the components and enter their specification and functions.

Table 2 : Tabular column for electrical components of IDU and ODU

Sl. No	Name of the component	Specification (as per manual)	Function
A			
B			
C			
D			
E			
F			
G			
H			
I			
J			

Table 3 : Tabular column for electronic components of IDU and ODU

Sl. No	Name of the component	Specification (as per manual)	Function
A			
B			
C			
D			
E			
F			
G			
H			
I			
J			

— — — — — — — —

Check and service the VRF/VRV system

Objectives: At the end of this exercise you shall be able to
- **check various parameters and components of VRF/VRV system**
- **service the VRF/VRV system.**

Requirements

Tools/Instruments

- Screw driver (150mm & 300mm) - 1 No.each
- Double ended spanner - 1 No.
- Combination plier - 1 No.
- Adjustable wrench - 1 No.
- Voltmeter - 1 No.
- Clamp meter - 1 No.
- Sling psychromotor - 1 No.
- Electronic leak detector - 1 No.

Equipment/Machines

- VRF/VRV air-conditioner system - 1 No.

Materials

- Air blower - 1 No

PROCEDURE

TASK 1: **Check various parameters and components of VRF/VRV system**

1 Check current and voltage drawn by the unit using clamp meter and volt meter, match it with the specification given in manual. Record in record sheet.

2 Check condenser and evaporator temperature by digital thermometer. Record in record sheet.

3 Check DBT and WBT temperature by sling psychromemter and calculate the corresponding RH. Record in record sheet.

4 Check suction and discharge pressure using gauge manifold and connecting the manifold's gauges with the suction and discharge line using hoses. Record in record sheet.

5 Check safety controls like HP cut out switch, LP cut out switch etc.

6 Check for any current leakage from the wiring circuit

7 Check for any refrigerant leakage using electronic leak detector.

8 Check for vibration and use vibration eliminator where vibration is noticed.

— — — — — — — —

TASK 2: **Service the VRF/VRV system**

1 “OFF” the main supply of VRF/VRV air conditioner.

2 Open the front panel of the ODU.

3 Clean the system by using air blower.

4 Clean the condenser.

5 Tighten any loose connection in electrical connection.

6 Top up refrigerant if it is less. (Refer Ex: 290)

7 Close the front panel of ODU.

8 Open front panel of IDU.

9 Remove air filter and clean it.

10 Service IDU of VRF system.

11 Return the air filter and close the front panel.

12 Start the unit and check the performance.

Record Sheet

Current Drawn (AMP)	Voltage Drawn (V)	DBT (ºC/ºF)	WBT (ºC/ºF)	RH (%)	Suction Pressure (kg/cm^2)	Discharge Pressure (kg/cm^2)

— — — — — — — —

Identify error code for VRF/VRV system

Objectives: At the end of this exercise you shall be able to
- **identify error code for IDU of VRF/VRV system**
- **identify error code for OUD of VRF/VRV system**
- **identify error code for system of VRF/VRV system.**

Requirements

Tools/Instruments

- Screw driver 6mm x 150mm - 1 No.
- Line tester - 1 No.
- Multi meter (Digital) - 1 No.
- Tong tester - 1 No.
- Navigation remote controller - 1 No.
- Service checker - 1 No.
- Pressure gauge - 1 No.
- L - Allen key set - 1 Set
- Micro computer - 1 No.

Equipments

- VRV/VRF system

PROUDURE

TASK 1 : **Identify error code for VRV/VRF system IDU from service**

1 Bring the trainees to the VRV/VRF system.

2 Open the control panel and check for displayed error in display panel of the system.

3 Check for description of error in the display of error given in the tables below for IDU/ODU and system of VRF/VRV.

4 Note the error code against the error displaying in the display panel from the service manual of the system.

5 Tally the errors (showing) displaying in the display panel with the errors provided in the tables and identify the error codes.

6 Note down the error codes in the table provided with "description of error", and "description of diagnosis.

NOTE

The error codes for the system (VRF/VRV) can varies depending on manufacturer.

SI No.	Error code	Description of errors	Description of diagnosis
1		External protection device abnormality	• Check for the setting state of the external ON/OFF input by remote controller.
2		PCB abnormality.	• Turn the power supply off, then the power ON again, if the system does not return to normal, replace the IDU PCB.
3		Drain level control system abnormality.	• Check for defective float switch or short circuit connector. check for power supply (208 & 230 V). Check for defective drain pump, drain clogging, defective IDU PCB also check for loose connecting of connector.
4		Fan motor lock, over load	• Check for broken wire, short circuit or disconnection of connectors from fan motor harness. • Check for defective fan motor. • Check for defective IDU PCB. • Check for any for matters blocking the fan. • Check the IDC fan motor and the wiring circuit of the motor.

Sl No.	Error code	Description of errors	Description of diagnosis
5		IDU fan motor abnormality.	• Check for broken wires. • Check for connectors securely connected or not. • Check the IDU fan motor and the wiring circuit of the motor.
6		Swing flap motor abnormality.	• Check for the power supply of 208-230 V. • Check for the continuity of relay cable. • Check the air flow direction flap cam mechanism.
7		Power supply voltage abnormality.	• Check if power supply voltage in 208-235V • Check if there is power open phase or defective wiring • Check if power voltage unbalance is within 6V or not.
8		Electronic Expansion valve coil abnormality/Dust clogging	• Check coil condition of electronic expansion valve by using a micro-computer. • Check dust clogging condition of electronic Expansion valve main body by using micro computer.
9		Capacity determination device abnormality	• Check whether capacity setting adapter is installed or not. • Check for defective IDU PCB.
10		Transmission abnormality between IDU PCB and Fan PCB	• Check the connection between the connectors of IDU PCB and fan PCB. • Check for defective fan PCB. • Check for defective IDU PCB.
11		Thermistor abnormality	• Remove the thermistor from the IDU PCB and insert it again. If it works normal the error is caused by defective contact. If it does not work normal. Check thermistor's resistance with multi meter. Check the valve range must come between 5KΩ to 90KΩ . It not replace the thermistor.
12		Combination error between IDU PCB and fan PCB.	• Check the condition of transmission with fan PCB using IDU PCB.
13		Remote sensor abnormality	• Check for defective IDU thermistor for air inlet • Check for defective IDU PCB. • Check the resistance of sensor after disconnecting from PCB.
14		Humidity sensor system abnormality.	• Check if the moisture sensor is disconnected or short circuited. • Check for the defective sensor.
15		Room temperature thermistor in remote controller abnormality.	• Check for defective room temperature thermistor in remote controller. • Check for defective remote controller PCB.

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TASK 2 : **Identify the error codes for IDU of VRF/VRV system against description of error (provided in the table) after tallying the error with the service manual. Also make a detailed diagnosis of the errors as per the steps provided below.**

SI No.	Error code	Description of errors	Description of diagnosis
1		PCB abnormality	• Turn OFF the power once and turn ON again. IF it not return to normal. Check it in side/outside relay wires of outdoor unit PCB is disconnected or not.
2		Actuation of high pressure switch	• Check if the stop valve open or not • Check if the high pressure switch connector properly connected to the PCB control or not. • Check if there is continuing across the HP switch • Check if operating pressure is 4.0mpa
3		Actuation of lower pressure sensor.	• Note whether its operating pressure is 0.07 mpa or not. • Check if the stop valve is open or not • Check the characteristics of low pressure sensor by connecting service checker and then make a comparison between low pressure checked by service checker and the measurement of the sensor.
4		Inverter compressor meter lock.	• Check whether ODU PCB takes the position signal from the phase line connected between the inverter and compressor • Check if any abnormality is observed in the phase - current wave form.
5		Outdoor fan motor abnormality	• Check for the connections of all fan motor connectors. • Check for continuity across the fuse on the fan inverter PCB.
6		Electronic expansion valve coil abnormality	• Check for disconnections of connectors from EXV. • Check for defective EXV coil • Check for defective ODU PCB
7		Discharge pipe temperature abnormality	• Check the characteristics of the discharge pipe and the compressor surface temperature thermistors are normal or not • Check for defective outdoor PCB
8		Refrigerant overcharged.	• Detect overcharged refrigerant according to outdoor air temperature heat exchanging deicer temperature, and liquid pipe temperature.
9		Outdoor unit fan motor signal abnormality	• Check if the connector of signal cable of the relevant fan motor normally connected or not • Check for the connector of the fan motor.
10		Thermistor abnormality	• Check the resistance of thermistor with multi meter for normal range of 1.8KΩ to 8.00KΩ.
11		Inverter PCB abnormality	• Turn OFF the power supply once, and then turn it ON again. • Check whether it acts normally or not. • Check the power transistor normal working.

Sl No.	Error code	Description of errors	Description of diagnosis
12		Inverter compressor over current	• Check for the disconnection in compressor coil. • Check for the disconnection of compressor wiring.
13		Inverter compressor start up abnormality	• Check the stop valve is open or not. Check any error in wire connection to compressor. • Check for defective inverter PCB.
14		Transmission error between inverter and control PCB	• Check for defective connection between inverter PCB and the control PCB using a micro-computer.
15		Power supply voltage in balance.	• Check for defective capacitor in the main circuit. • Check for defective wiring and defective magnetic relay.

TASK 3 : **Identify the error code for the system error displayed in display panel after tallying the error description as provided in the table below and also with the service manual.**

Sl No.	Error code	Description of error	Description of diagnosis
1		Refrigerant shortage	• Defect refrigerant shortage by checking the low pressure sensor's characteristics. Check the low pressure valve by using pressure gauge compare the actual measurement of the low pressure between pressure gauge valve and sensor's valve.
2		Reverse phase, open phase	• Check if there is an open phase at the power supply terminal section of the ODU.
3		Transmission error between IDU and ODU	• Check if short circuited between indoor - outdoor or outdoor - outdoor transmission wiring or wrong wiring • Check if outdoor power supply is OFF • Check for defective IDU and ODU PCB.
4		Transmission error between remote controller and IDU	• Check for noise in surrounding. • Check for remote controller PCB • Check for IDU PCB.
5		System is not set yet	• Check for improper connection of transmission wiring between indoor- outdoor- and outdoor - outdoor units. Check for defective IDU PCB. Check for stop valve is not opened.

Caution : Be sure to turn off the power switch before connecting or disconnecting connectors or parts may be damaged.

Service various components of indirect expansion type central A/C plants

Objectives: At the end of this exercise you shall be able to
- **service the refrigeration system components**
- **service the electrical components.**

Requirements

Tools/Instruments
- Chiller plant 5 ton capacity

Materials
- Cotton waste, Record sheet - 2

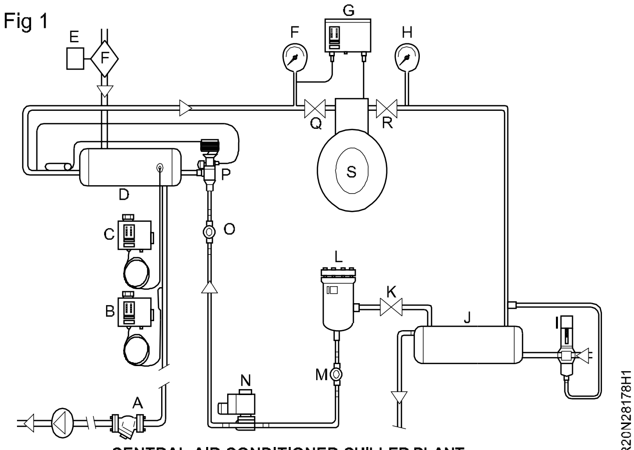
PROCEDURE

TASK 1 : **Service the refrigeration system components (Fig 1)**

1 Switch off the plant.
2 Clean with cotton waste.
3 Minutely observe the components.
4 Record in tabulated sheet.

Sl. No.	Code	Name of the components	Purposes
1	A		
2	B		
3	C		
4	D		
5	E		
6	F		
7	G		
8	H		
9	I		
10	J		
11	K		
12	L		
13	M		
14	N		
15	O		
16	P		
17	Q		
18	R		
19	S		

Fig 1



CENTRAL AIR CONDITIONER CHILLER PLANT

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TASK 2 : **Service the electrical components**

1 Identify electrical components.

2 Record in sheet their location.

Sl. No.	Name of the components	Specification	Make	Location
1	Under/Over Voltage Current Transformer			
2	Water Temp Sensor Pair			
3	Oil Temp Sensor Pair			
4	Outdoor Air Temperature Sensor			
5	Zone Temp Sensor			
6	Connector (UCM mating connectors)			
7	Connector Keying Plug			
8	Electronic Expansion Valve			
9	High pressure Cut out Switch			
10	Low pressure Cut out switch			
11	Variable Speed Fan Drive			
12	Motor Temperature Thermostats			
13	Slide Valve Load/Unload Solenoids.			
14	Steps Load Solenoid Valve			

Signature of trainees

Signature of Instructor.

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Check electrical circuit of indirect expansion type central A/C plants

Objectives: At the end of this exercise you shall be able to
- **trace electrical circuit of chiller plant.**

Requirements

Tools/Instruments

- Chiller plant 20 Ton capacity - 1 No.
- 150 mm screw driver - 1 No.
- 150 adjustable spanner - 2 Nos
- Double end spanner set (8 to 24mm) - 1 Set
- 0-10 kg. low pressure switch bellow type - 1 Set
- 2 way solenoid valve - 1 No.
- Continuity tester battery operated - 1 No.

Materials

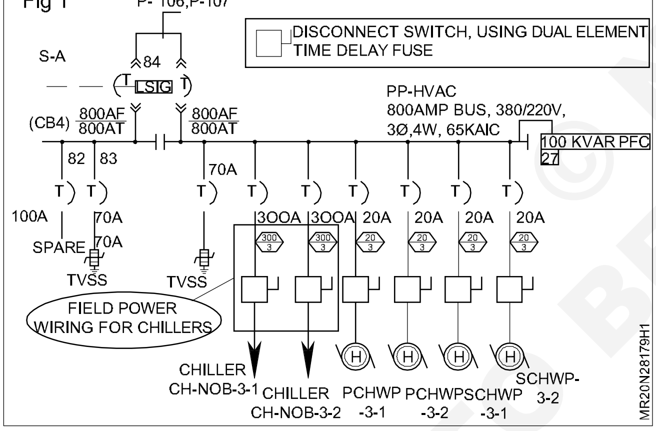
- Soft cotton cloth - as reqd.
- Water, emery cloth
- Nitrogen cylinder with 2 stage regulator

PROCEDURE

TASK 1 : **Trace electrical circuit of chiller plant**

1 Time delay circuit Fig 1.

Fig 1



2 DOL Starter circuit breaker Fig 2.

3 Combination heavy duty starter Fig 3

Fig 3

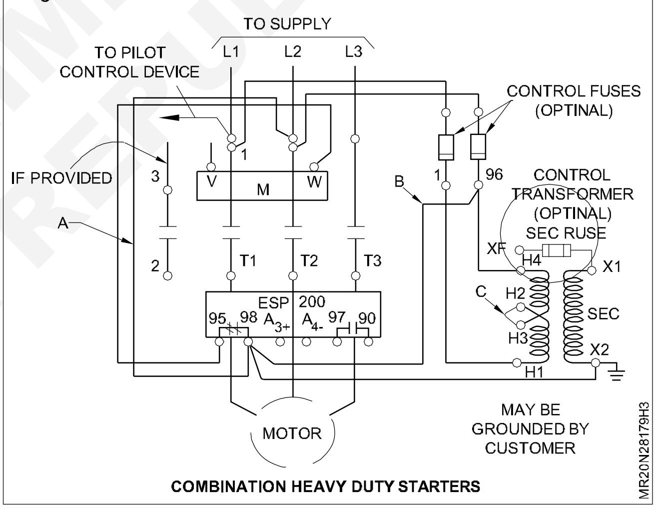
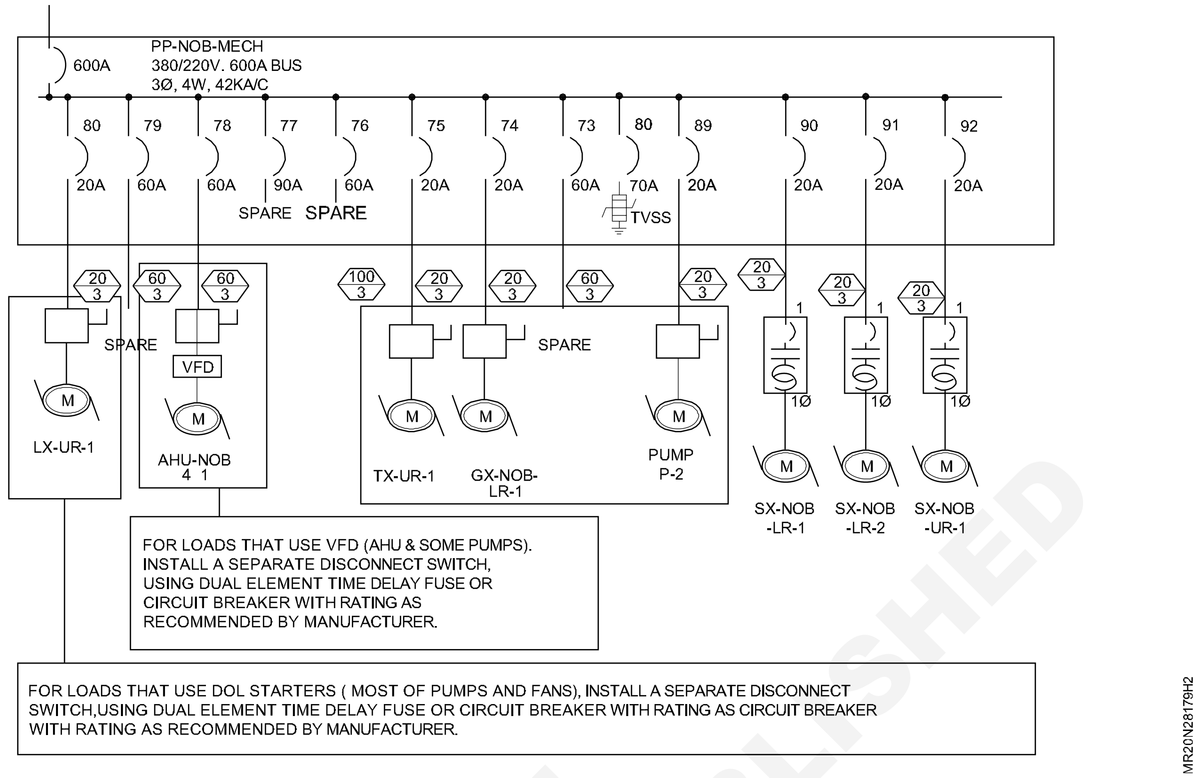
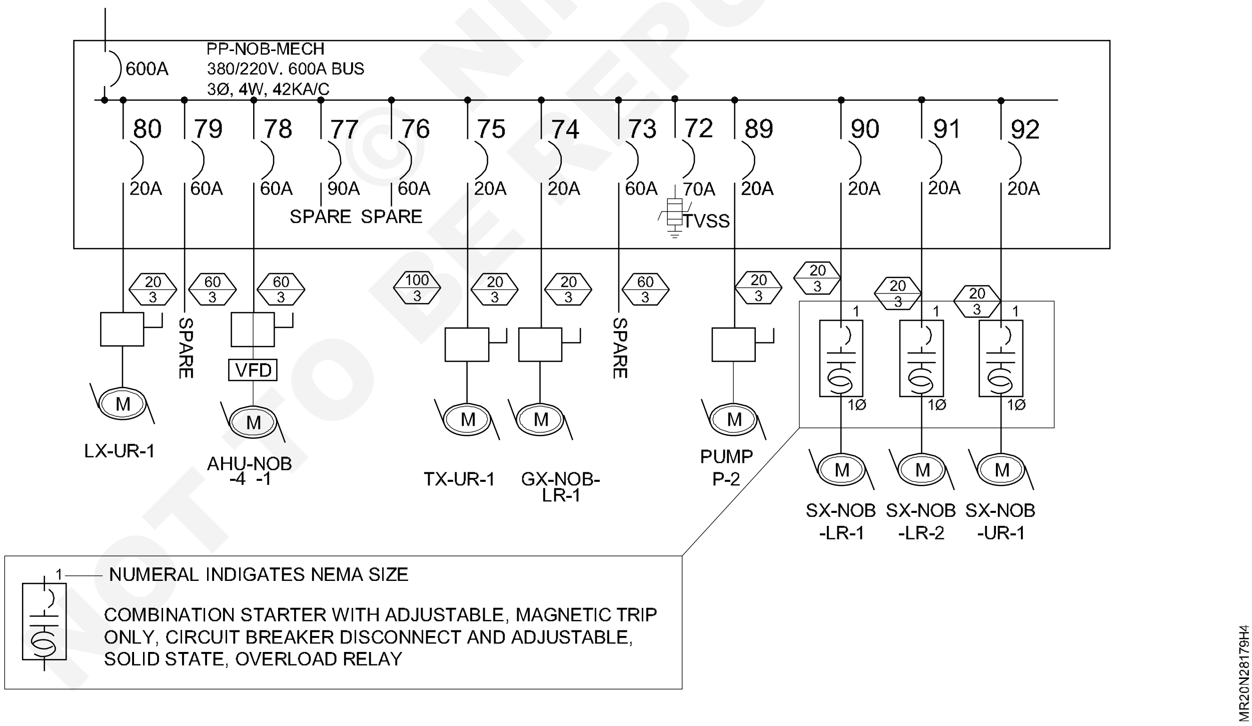


Fig 2



4 Combination starter with magnetic relay Fig 4.

Fig 4



Insulate chilled water pipings

Objectives: At the end of this exercise you shall be able to
- **insulate chilled water straight pipings**
- **insulate 45° and 90° elbows**
- **insulate flanges, couplings, tees and valves.**

Requirements

Tools/Instruments

• Hack saw blade with frame	- 1 Set.
• Double ended spanner (8 to 24mm)	- 1 Set.
• Ring spanner set (8 to 24mm)	- 1 Set.
• Adjustable pipe wrench	- 1 No.
• Screw driver (300mm long)	- 1 No.
• Hammer (250 and 500 gm)	- 2 Nos.
• File (Different types)	- 1 Set
• Steel tape (5 mtr)	- 1 No.
• Calipers	- 1 Set
• Self threading screws	- as reqd.
• Aluminium sheets	- as reqd.
• Gasnet cutter	- 1 Set.

Equipment/Machines

- 10 TR chiller plant with bare pipings

Materials

• Clean cloth	- as reqd.
• Mineral fibre	- as reqd.
• Seal tape	- as reqd.

PROCEDURE

TASK 1 : **Insulate chilled water straight pipe**

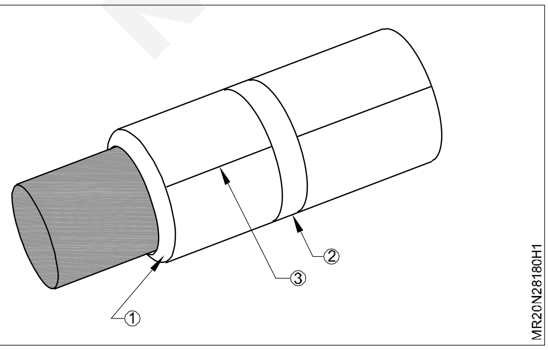
1 Check all inspection and acceptance testing of the piping as required by specification has been completed and that the piping is ready for installation of insulation (e.g. check for leak in piping).

2 Check all the surfaces are clean, dry and any other extraneous chemicals such as corrosive cleaners or building materials dust.

3 Check if there is adequate clearance to install the mineral fibre pipe insulation in accordance with drawings, operation performance parameters of the specification, such as access to controls, valves and for maintenance and repair.

4 Insulate each continuous run of piping with full-length tubes of mineral fibre insulation with single pieces cut to complete the end of the run. (for pre. formed insulation tubes) (see Fig 1)

Fig 1



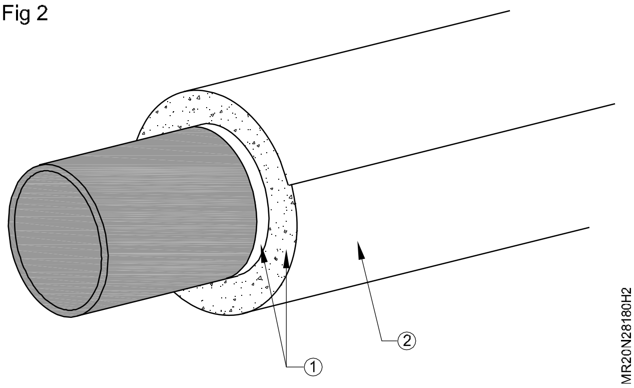
5 Push on to pipe the insulation but not pull it.

6 Install all joins and seams by compression fitting.

7 Over lap insulation 5-10mm (1/4^{n}) at butt edge seams and compress the edges into place, so that there should no gap present at any joint.

8 Install vapor dams or vapor seals at every butt edges and at the termination of the termination of all fittings.(see Fig 2)

Fig 2



9 Seal all pipe insulation longitudinal or circumferential joints using the self- seal lap and butt strips.

10 Rub the self-seal lap and butt strips firmly with a sealing tool such a squeegee to assure proper adhesion. (see Fig 3)

Fig 3

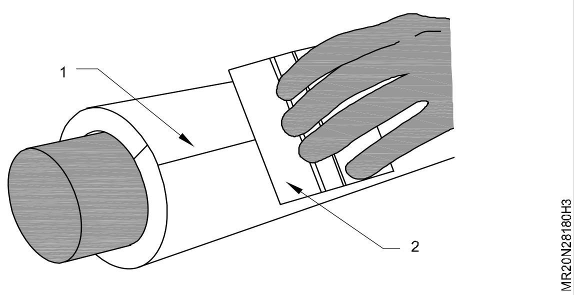
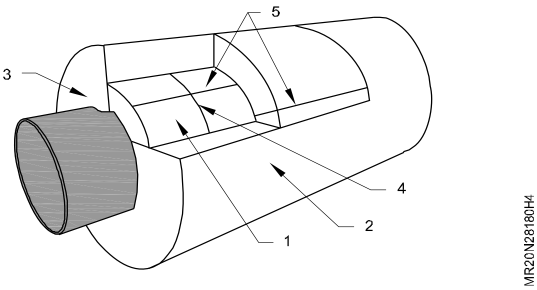


Fig 4



11 Seal the butt end of every fourth pipe insulation section, and the ends or raw edges of insulation terminations at equipment connections, fittings or fire stop systems with vapor retarder mastic.

12 Terminate the staggered ends at the vapor dam and a vapor retarder applied to the entire exposed raw edges of the insulation for multi- lager systems. (Fig 4)

13 Stagger the insulation seams when applying multiple layers of insulation.

14 Adhere directly the insulation to the pipe at the beginning at every 4m to 6m and at the ends of piping runs with a 50mm strip of adhesive.

15 Insulate hangers clamped directly to the pipe.

NOTE

Do not us cut pieces or scraps.

All pipe insulation shall be continuous through wall and ceiling opening except where fire-stop materials are required.

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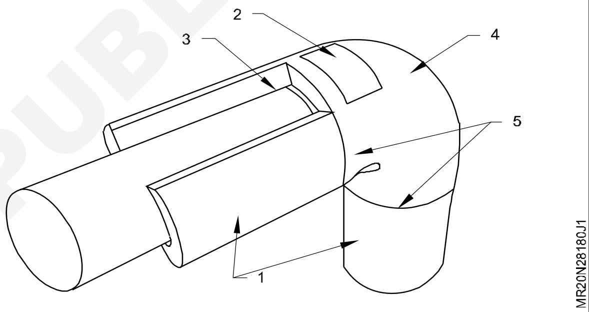
TASK 2 : **Insulate 45° and 90° elbows**

1 Insulate the elbows using preformed or moulded insulation or field fabricated from a straight section of pipe insulation or insulate using mineral fibre blanket inserts.

2 Insulation should be mitered pre-adhered and longitudinally slit inside throat to fit over all elbows and bends. (Fig 1)

1) Performed mineral fiber pipe insulation with vapor retarder jacket. 2) Fabricated or mitered or moulded mineral fiber pipe insulation. 3) Vapor dam. 4) PVC fitting cover. 5) Apply PVC vapor seal tape or adhesive/solvent to all joints

Fig 1



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TASK 3 : **Insulate flangers, couplings, Tee and valves**

1 Insulate any fittings with mineral fibres, vapour dam for efficient working of the chiller unit.(Fig 1)

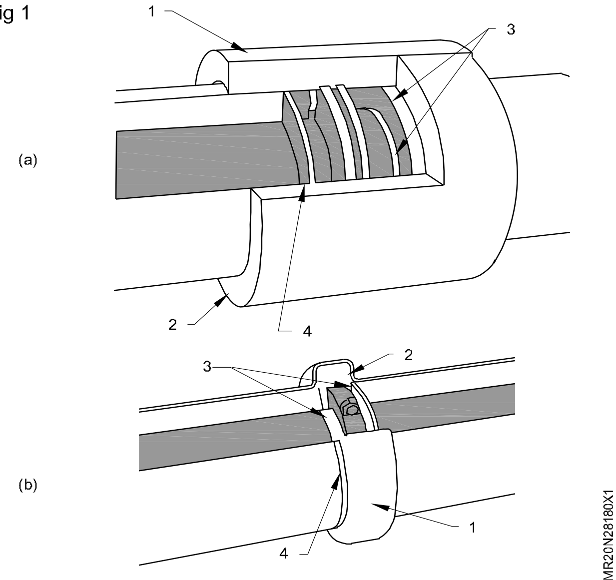
a Applied Jacket, Vapor dam, Vapor dam at straight section of pipe, Vapor retarder mastic on joints and terminations

b PVC molded fitting cover, Mineral fiber insulation, Vapor dam, Vapor retarder mastic or PVC tape on joints

NOTE

Protective covering must be installed on areas of insulation that are exposed to weather or subject to mechanical damage.

Fig 1



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Service of FCU and water control valves

Objectives: At the end of this exercise you shall be able to
- **service and maintain fan coil unit**
- **check and service water control valves.**

Requirements

Tools/Instruments

- Double ended spanner and ring spanner set (4 to 27mm) - 1 Set.
- Adjustable pipe wrench - 1 Set.
- Steel tape (5 mtr) - 1 No.
- Screw driver, hammer, file - 1 Set.
- Pressure gauge - 1 No.

Equipment/Machines

- Chiller unit with FCU and water control valves.

Materials

- Clean cloth - as reqd.

PROCEDURE

TASK 1 **: Service and maintain fan in Fan Coil Unit (FCU)**

1 Stop the unit after getting clearance from instructor.

2 Dismantle the fan-motor compartment.

3 Wipe the fan- motor, clean the filters, coils-fins.

4 Lubricate the motor and fan as recommended.

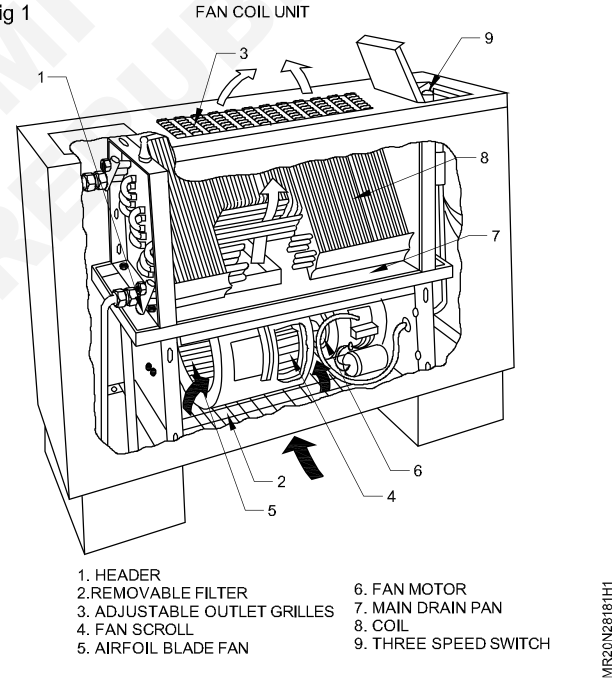
5 Check the fan's hub locking screw (nut) and base bolts and tighten it.

6 Rotate the fan manually, check for free rotation.

7 Wipe the total unit with clean cloth and assemble the cabinet.

8 Start FCU, check for the fan motor current with tong tester is normal and check the air-velocity also.

Fig 1



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TASK 2 : **Check and service water control valves**

Start the air handling unit, ensuring that dampers in the supply duct are fully open.

- Open air control valve and observe throw supply air flow.
- Open air control valve and observe throw return air flow.

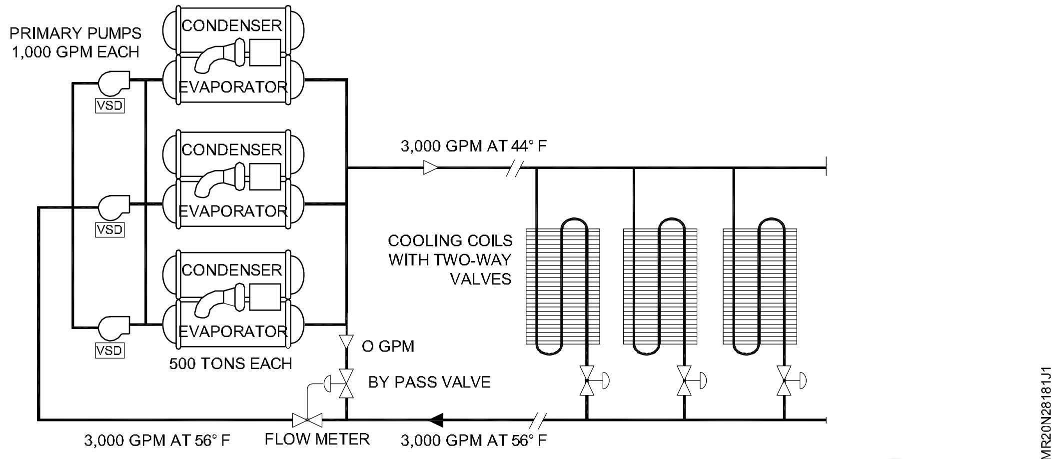
Cooling coil water control valve (Fig 1)

Open all water valves and start the water pump**.**

Observe pressures at condenser inlet and outlet.

Observe pressures at cooling coil inlet and out.

Fig 1



Cooling by pass and flow control valve

Open bypass valve note down the reading.

Open flow meter valve note down the reading pressure on meter.

Open all water valves and start the water pump. Observe pressures at condenser inlet and outlet lines.

Open hot-gas valve on the condenser and the discharge service valve on the compressor. Open discharge gauge valve to read the pressure.

Follow the same procedure and read the suction pressure.

Open liquid line valve. Observe standing pressure on the gauges. This should be approximately 7.03 kg/cm^2 (100 psi) for R-12 and 10.5 kg/cm^2 (150 psi) for R- 22 to indicate that the system is tight with no leakage.

Open suction service valve and start the compressor. Observe the refrigerant and oil pressures.

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Check vibration eliminator and water proofing insulation

Objectives: At the end of this exercise you shall be able to
- **service and rectify vibration and noise in the duct line**
- **service and rectify the water proofing insulation faults.**

Requirements

Tools/Instruments

• Screw driver 3mm tip, length 100mm	- 1 No.
• Scriber	- 1 No.
• Pliers flat nose length 150mm	- 1 No.
• Pliers long nose length 200mm	- 1 No.
• Sheet metal snipper 200mm	- 1 No.
• Hand drill machine with 6mm drill bit	- 1 Set.
• Knife, folded S.S 150mm	- 1 No.
• Pop rivet gun	- 1 No.

Equipment/Machines

- 10 TR chiller plant with bare pipings
- 5 TR Air-conditioning plant equipped with AHU or air-washer and complete duct system.
- Refrigeration plant using chilled water circulation

Materials

• Insulation/vibrating eliminator	- as reqd.
• Engg. rule 300mm long	- 1 No.
• Marker pen	- 1 No.
• Ladder	- 1 No.
• Goggles	- 1 No.
• Rubber pads	- 1 No.
• Water proofing insulation	- as reqd.

PROCEDURE

TASK 1 : **Service and rectify vibration and noise in the duct line**

1 Start the air- conditioner plant and AHU or air -washer

2 Wait till the plant to stabilize.

3 Check the duct line and carefully mark the vibration areas.

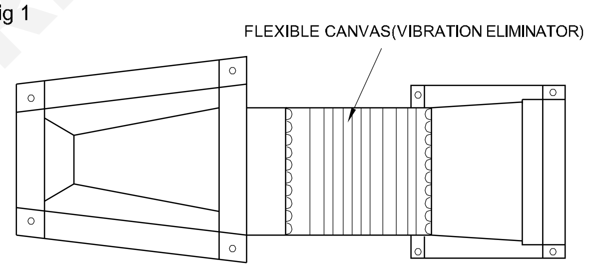
4 Give support for the duct with hanging clamps appropriately from where the vibration is happening.

5 Check for the puncture of flexible canvas.

6 If puncture found in the canvas, remove the canvas measure and cut of same site and fix it firm and tighten with joint frames. (Fig 1)

7 Star the unit, check for vibration noise.

Fig 1



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TASK 2 : **Service and rectify the water proofing insulation faults.**

1 Check all over the chilled water pipes, valves and the storage tank, wherever the insulation are weak mark it.

2 Replace the same with suitable insulation.

3 Where the thermocole is used, first apply liquid (hot) bitumen (melted by heat source) on the pipe’s outer area, then fix the thermocole firmly as per the shape.

4 Fill the air gaps in the joints of insulation with bitumen, then cover it with aluminium sheets and tighten it with self threaded screws. Fig 1, 2 & 3)

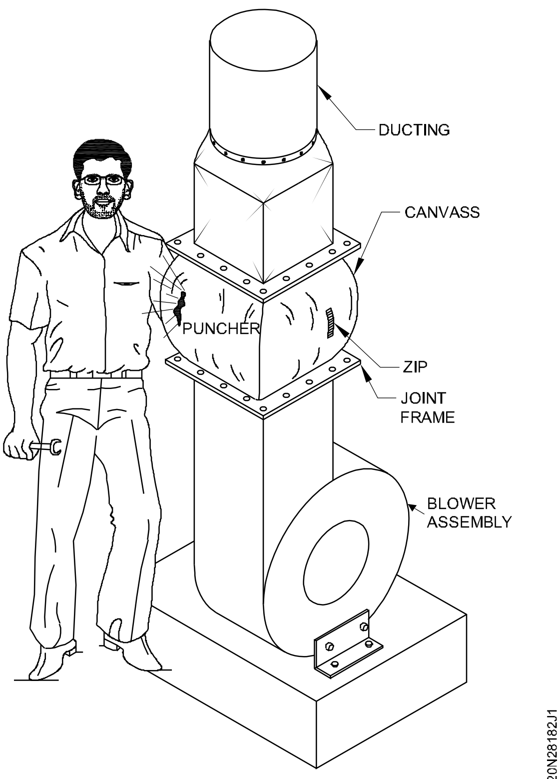
5 Wherever the mineral wool is packed for insulation, cover it with thin wire mesh and bind it water proof plastic sheet, then apply correct combination of cement paste, leave it to dry.

6 After correcting all the leaks and insulation faults, open the water valves, vent the air (locks) by the pumps and the lines.

7 Start the chilled water pump and leave the water to circulate.

8 Finally once again check all over , for any leak, if there is no leak, start plant and put in normal operation.

Fig 1



FLEXIBLE CANVAS (VIBRATION ELIMINATOR)

Fig 2

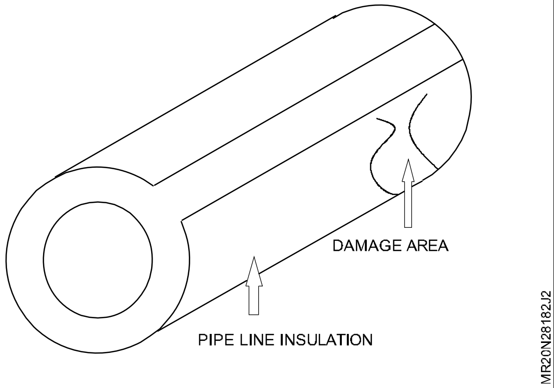
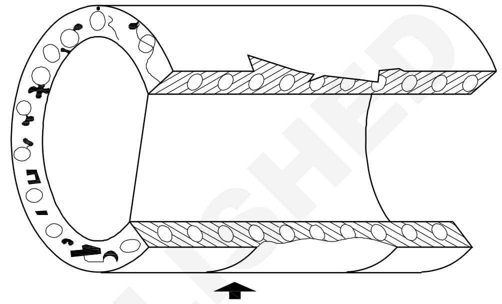


Fig 3



Check different controls used in central A/C system

Objectives: At the end of this exercise you shall be able to
- **check high pressure safety switch and oil pressure switch**
- **check low pressure safety switch, liquid solenoid valve.**
- **check electronic thermostat and thermostatic expansion valve**
- **check water regulating valve.**

Requirements

Tools/Instruments

• Multi meter	- 1 No.
• Screw driver (150mm)	- 1 No.
• Nose plier	- 1 No.
• Volt meter	- 1 No.
• Tester	- 1 No.
• Dry N2 cylinder with pressure regulator	- 1 Set.
• Combination plier	-1 No.

Equipment/Machines

- 5 TR indirect type of central A/C plant

Materials

• Water emery	-as reqd.
• Banian cloth	-as reqd.

PROCEDURE

TASK 1 : **Check high pressure safety witch and oil pressure switch**

1 Calibrate the switch and set the cut out pressure

2 Keep nitrogen cylinder regulators in closed position by keeping the handle fully loose.

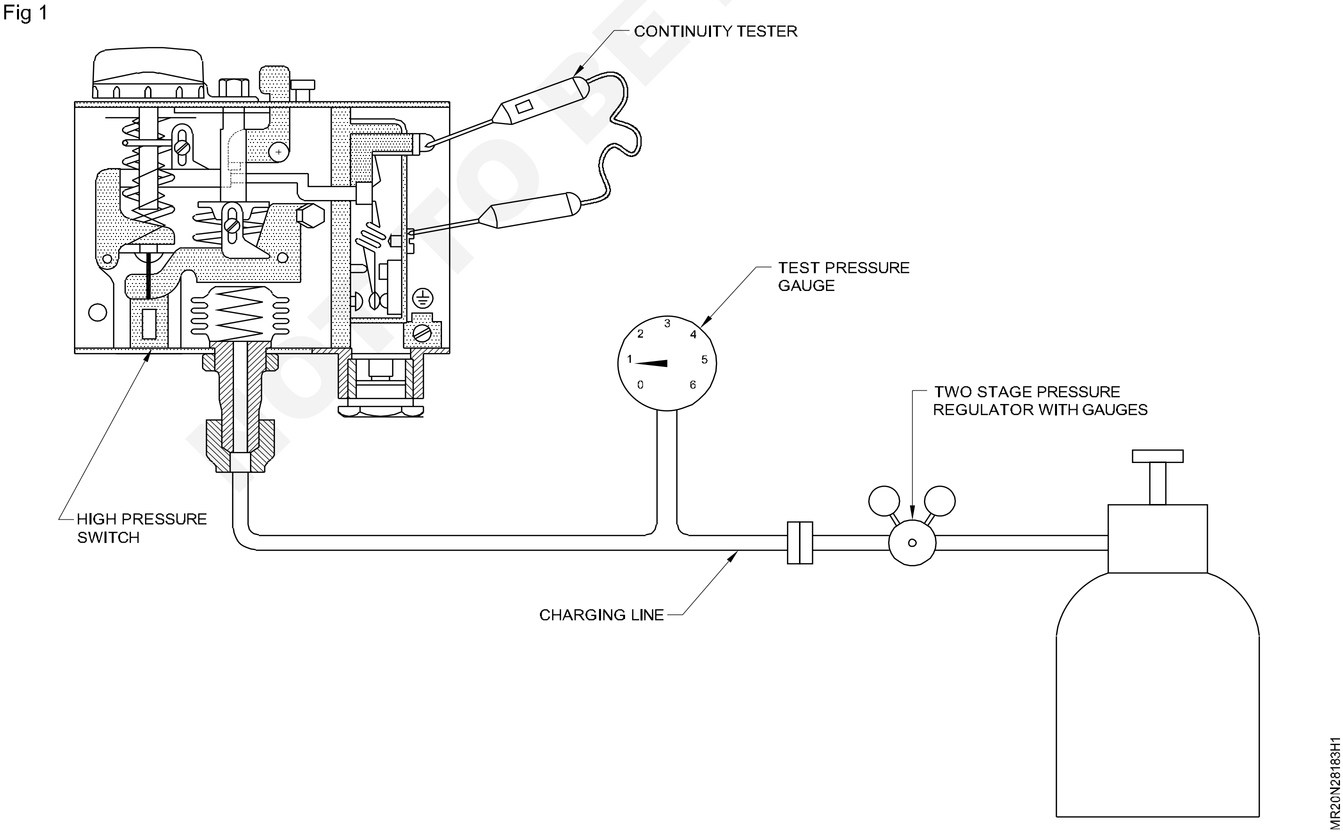
3 Open the nitrogen cylinder valve with the valve key.

4 Check the cylinder pressure on the dial in Gauge 1.

5 Connect the charging hose to the pressure switch as shown in Fig 1.

6 Set the required pressure on the regulator gauge No.1 and on line pressure gauge.

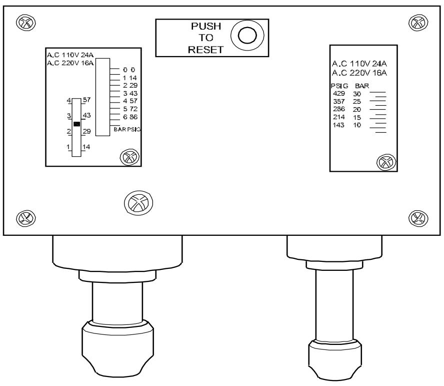
Fig 1



7 Watch the movement of the spring and place the battery operated continuity tester leads on the terminal across NO & NC terminals, the light should not glow. This indicates that the switch has cut out.

8 Reduce the nitrogen pressure by loosening the flare nut No.10 when the pressure drops to differential pressure. Place the continuity tester probes on the terminals the light will glow. This indicates that the switch has reset.

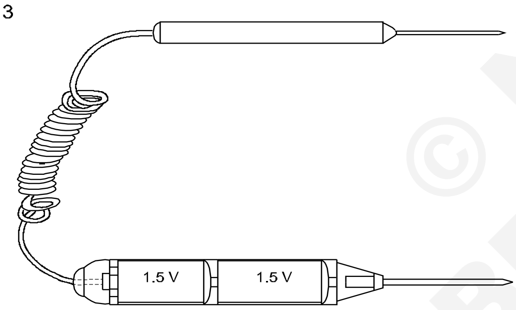
Fig 2



Example: The Freon 22 water cooled condenser, High pressure cut out at 16.0 kg/cm^2.The reset is 14.0kg/cm^2. The differential is 2.0 kg/cm^2.

Check and service safety valve (Fig 3)

Fig 3



CONTINUITY TESTER WITH 1.5V PENTORCH CELL 2 NOs

Check the safety valve lifting pressure

1 Prepare the end fitting of safety valve to match the charging hose connection 25 x 6 mm reducer.

2 Connect the safety valve to Nitrogen cylinder with the charging hose.

3 Ensure that the nitrogen cylinder regulator is tight and gauges are OK.

4 Open the nitrogen cylinder valve with the valve key.

5 Tighten the regulator key so that the gauge No.2 reads 21.0 kg/cm^2.

6 At this pressure the safety valve should lift.

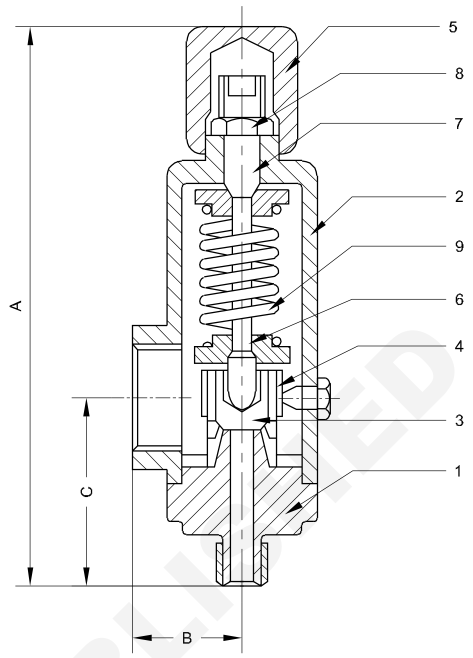
7 If it opens before or does not open at 21.0 kg/cm^2.

8 Then the adjustable screw No.10 to be adjusted (by tightening).

9 Close nitrogen cylinder and remove valve, after setting pressure To increase the spring tension No.8 by this the set pressure is to be reduced adjust screw 7 (by loosening).

10 Tighten the check nut 8 and fix the Cap. No.5

Fig 4



SAFETY VALVE

Service the safety valve and set for lifting pressure

1 Dismantle all parts

2 Loosen the cap and remove

3 Loosen fully the adjusting Screw

4 Remove the spindle and top seating.

5 Loosen and remove locking screw.

6 Unscrew bottom seating.

7 Rinse all parts in kerosene and wipe dry with banian cloth.

8 Check the spring for proper shape.

9 Check bottom and top sealing for scoring.

10 Cap the seating in position by using smooth emery paste.

11 Clean and wipe both seating.

12 Assemble all parts and tighten the adjusting screw.

13 Set the lifting pressure as explained in Task 2, Procedure 1 Fig 5

Check and service oil pressure safety cut out

1 Connect one nitrogen cylinder to the oil pressure bellows (element) as illustrated in Fig 5

2 Connect the one more nitrogen cylinder to the crankcase bellows.

3 Open both the cylinder valves and set the required crank case pressure on the charging line gauge. Set the required pressure on the oil pressure charging line gauge. The pressure can be adjusted by adjusting the

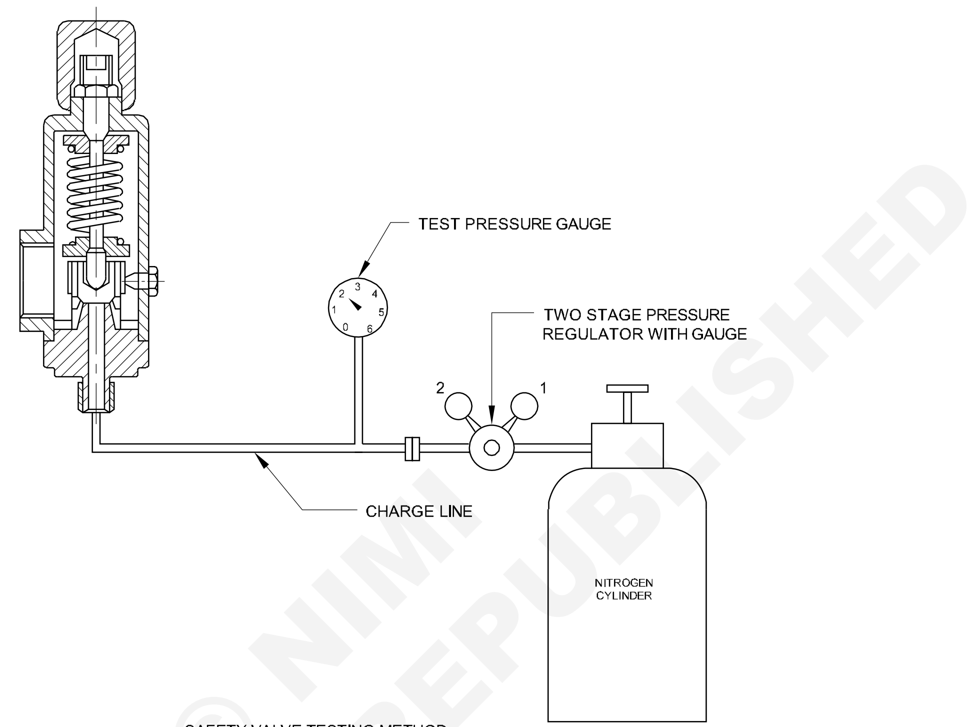
regulators. Then set the required differential on the switch scale.

Example: If the operating oil is 3.0 kg/cm^2. The operating suction pressured is 2.0 kg. The switch is 2.0 kg. The switch should be set for 3.0 - 2.0 = 1.0 kg differential.

4 Place the continuity tester probe on the leads of the switch.

When the oil pressure are set at mentioned above. The continuity test light should glow. This indicates that the switch is closed. Close the cylinder oil pressure charging cylinder, loosen the flare nut and drop the oil pressure to 2.0 kg. The contacts will open and the continuity tester light will not glow. This indicates that the switch is set OK (Fig 5).

Fig 5



SAFETY VALVE TESTING METHOD

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TASK 2 : **Check low pressure safety switch and liquid solenoid valve**

(Refer to Ex No. 307, TASK- 3 and TASK- 4)

— — — — — — — —

TASK 3 : **Check electronic thermostat and TXV**

Electronic thermostat

(Refer to Ex No.307, TASK- 5)

TXV

(Refer to Ex No.278, TASK - 3)

— — — — — — — —

TASK 4 : **Check water regulating valve**

(Refer to Ex No.311, TASK -2)

— — — — — — — —

Trouble shooting of central A/C

Objectives: At the end of this exercise you shall be able to
- **identify the fault and rectify for the complaint of "Compressor motor and fan do not start"**
- **identify the fault and rectify for the complaint of "Inadequate cooling"**
- **identify the fault and rectify for the complaint of "Unit short - cycles"**
- **identify the fault and rectify for the complaint of "Unit operates but does not dehumidify"**
- **identify the fault and rectify for the complaint of "Unit noisy"**
- **identify the fault and rectify for the complaint of "Unit runs but does not cool".**

Requirements

Tools/Instruments

- Trainee kit - 1 Set.
- Screw driver 300mm - 1 No.
- Cutting plier - 1 No.
- Charging manifold - 1 No.
- Hose pipes - 2 Nos.
- Flaring tool - 1 Set.
- Hammer - 1 No.
- Tong tester - 1 No.
- Double ended spanner - 1 No.
- Compressor oil - 2 ltrs.
- Brazing kit - 1 Set.

Equipment/Machines

- Central a/c plant with symptom of "compressor motor and fan do not start"
- Central A/c planet with symptom of "inadequate cooling" central A/c planet with symptom of unit short - cycles",
- Central A/c planet with symptom of "unit operates and does not dehumidify".
- Central A/c planet with symptom of unit noisy".
- Central A/c planet with symptom unit runs but does not cool".

Material

- Cotton waste - as reqd.
- Soap water - 1 ltrs.

PROCEDURE

TASK 1 : **Identify the fault and rectify for the complaint of "compressor motor and fan do not start"**

1 Follow the trouble shooting chart to rectify the above symptom.

Trouble Shooting Chart

Problem	Possible cause	Remedy
Compressor motor and fan do not start	1 Circuit breaker off or fuse bad.	1 Reset breaker or check fuses.
	2 Thermostat setting too high.	2 Reset thermostat to lower the temperature.
	3 Bad thermostat switch or wiring	3 Short between Y,R and G; if unit runs the thermostat must be replaced.
	4 Loose connections	4 Check wire terminal and tighten.
	5 Bad transformer	5 Check primary voltage (110/200), if power is there but no voltage on secondary wires (24 VAC), repair/replace as necessary.
	6 Bad compressor or fan.	6 Check and repair/replace as necessary.
	7 Bad relay in control panel.	7 Check and replace.
	8 HP-switch open.	8 Check for dirty, lined or obstructed condenser, bad condenser form relayer motor or bad HP-switch.
	9) LP-switch open.	9 Check for poor airflow through evaporator, bad LP switch, low freon pressure, dirty filter.
	10 Contactor winding shorted.	10 Check continuity in winding replace contactor if necessary.
	11 Bad wall thermostat.	11 Check or replace as necessary.

TASK 2 : **Identify the fault and rectify for the complaint of "Inadequate cooling"**

1 Follow the trouble shooting chart to rectify the above symptom.

Trouble Shooting Chart

Problem	Possible cause	Remedy
Inadequate cooling	1 Thermostat set too high. 2 Thermostat improperly located 3 Compressor or condenser fan not running. 4 Dirty condenser or evaporator. 5 Dirty filter 6 Blower wheel slips on shaft 7 Refrigerant low as shown by low amperage, evaporator not cold, or large portion of condenser cool 8 Lack of insulation on ducts 9 Air leaks in ducts 10 Insufficient air from evaporator 11 Leakage in system	1 Adjust to desired temperature. 2 Relocate thermostat away from drafts, out of direct sun light. 3 Check causes. 4 Clean condenser or evaporator 5 Clean or replace 6 Check and tighten allen screw. 7 Recharge after checking for restriction in capillary tube, strainers, TEV and filter-drier. Amperage should not be lower than shown on condensing unit nameplate. 8 Replace loose or missing insulation. 9 Check and repair. 10 Make sure duct dampers are open, duct runs are not too long nor too small. Adjust blower speed. 11 Check leakage in condenser, compressor evaporator, pipe line and arrest them.

— — — — — — — —

TASK 3 : **Identify faults and rectify for the complaint "Unit short - cycles"**

1 Follow the trouble shooting chart to rectify the symptom.

Trouble Shooting Chart

Problem	Possible cause	Remedy
Unit short-cycles	1 Low supply voltage 2 Temperature set too high 3 Faulty compressor 4 Faulty fan motor 5 Restriction in sealed system 6 Unit restarted too soon 7 Sensing element improperly located	1 Check for proper voltage. 2 Reset thermostat. 3 Check for short or ground. 4 Check for wrong or binding fan or blower wheel or wrong fan motor. 5 Check head and suction pressure clear restriction. 6 Advise customers to allow two to three minutes for pressure to equality. 7 Check location of sensing element or "Comfort guard" (a plastic sleeve) missing from sensing element.

— — — — — — — —

TASK 4 : **Identify the fault and rectify for the complaint of "Unit operates but does not dehumidify"**

1 Follow the trouble shooting chart to rectify the symptom.

Trouble Shooting Chart

Problem	Possible cause	Remedy
Unit operates but doesn't dehumidify	1 Defective fan motor	1 Check motor for continuity. If there is none replace fan.
	2 Restriction in scaled system	2 Check high and low pressure to deter mine if there is a restriction repair if necessary.
	3 Poor air circulation	3 Check to see that no furniture or other objects are placed closer than 6" from end grilles and that the grilles are clean and unobstructed.
	4 Area too large	4 Average area to be dehumidified should be no larger than LOMft^3 (10,000 cubic feet) for a single unit.
	5 Humidity too low	5 Unit is effective only when temperature is above 65°F and RH is above 60%; otherwise the air is too cool and dry for efficient operation.

— — — — — — — —

TASK 5 : **Identify the fault and rectify for the complaint of "Unit noisy"**

1 Follow the trouble shooting chart to rectify the symptom.

Trouble Shooting Chart

Problem	Possible cause	Remedy
Unit noisy	1 Loose parts or mounting	1 Check for loose parts, tubing vibrating against sides or components, loose fan, blower or mountings. Check for worn fan shaft bearings or loose parts in the unit.
	2 Faulty compressor	2 Could have internal parts worn. low on oil or low voltage.
	3 Puncture of canvas	3 Check canvas for its puncture or not. Replace if necessary.

— — — — — — — —

TASK 6 : **Identify the fault and rectify for the symptom "Unit runs but does not cool"**

1 Follow the trouble shooting chart to rectify the symptom.

Trouble Shooting Chart

Problem	Possible cause	Remedy
Unit runs but does not cool	1 Compressor not pumping	1 Check for restriction, loss of freon, or lowered capacity of compressor.
	2 Restricted air low	2 Check for obstruction in air passage and dirty filter.
	3 Low refrigerant as shown in ampermeter.	3 Top up gas.

— — — — — — — —

Identify various mechanical and electrical components used in car A/C

Objectives: At the end of this exercise you shall be able to
- **identify various mechanical components used in car A.C**
- **identify various electrical components used in car A.C.**

Requirements

Tools/Equipments

•	Screw driver 300mm long	1 No.
•	Screw driver 150mm long	1 No.
•	Double ended spanners (open end)	1 Set.
•	Auto AC system	1 Set.

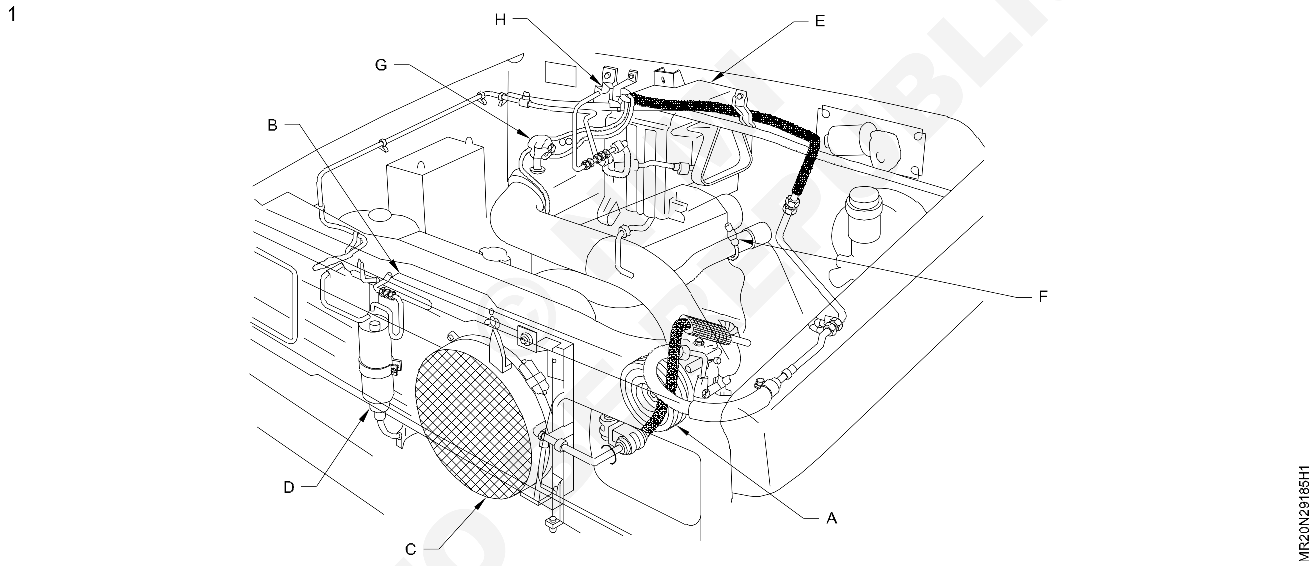
Materials

•	Clean cotton cloth	0.5 sq.m.

PROCEDURE

TASK 1: **Identify the components, controls and safe devices (Fig 1)**

Fig 1



1 Take the vehicle/auto AC system to the safe convenient place.

2 Clean the outer surface of a vehicle/auto AC system by a clean cloth.

3 Open the bonnet/front cover carefully.

4 Observe the components thoroughly.

5 Identify the labelled components (Refer Figs.2-9) and controls and record their names with the locations, functions and specifications (if any) on the record sheet which is given at the end of this exercise.

6 Make sure that observed the details of all components.

7 Close the front cover/bonnet with care.

8 Fillup data's in the record sheet.

9 Get it approved/verified by your instructor.

Fig 2

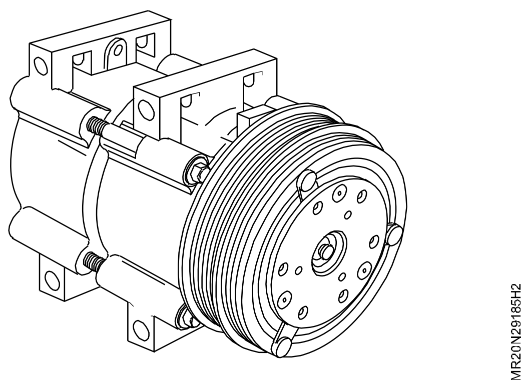


Fig 3

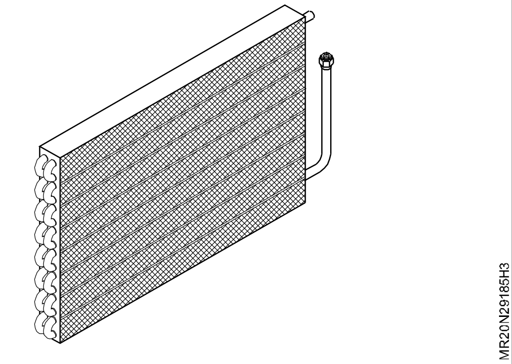


Fig 4

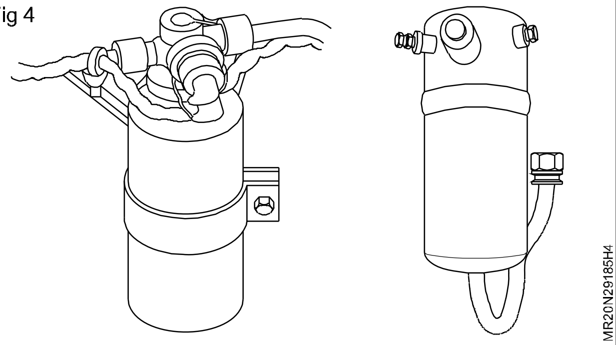


Fig 5

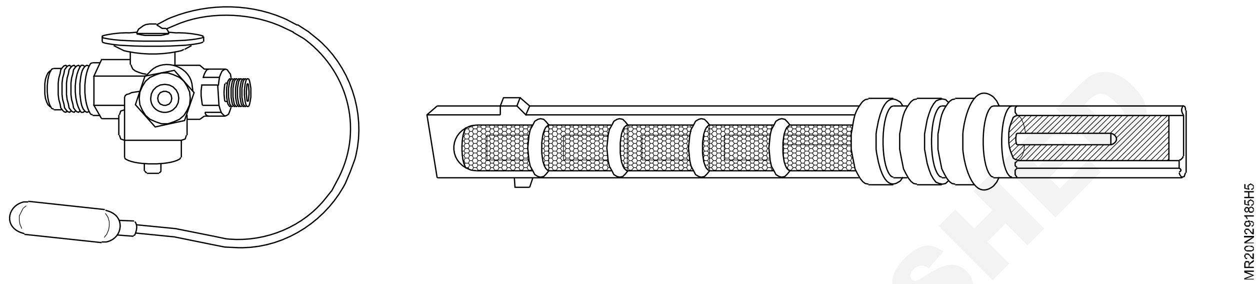


Fig 6

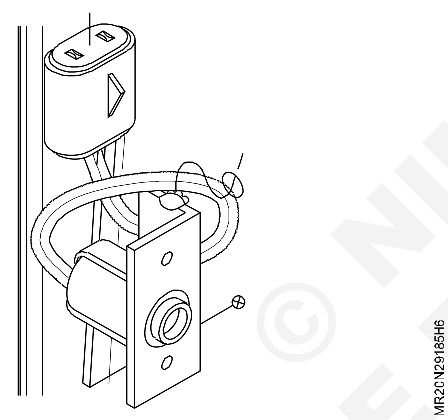


Fig 7

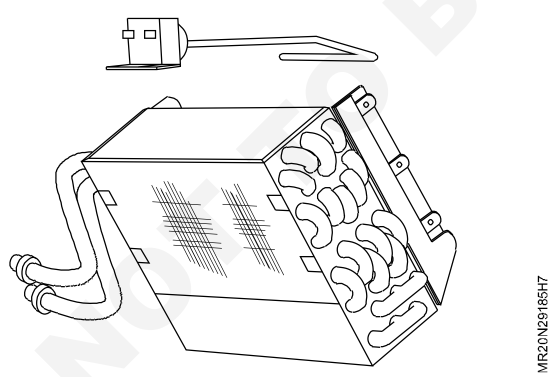


Fig 8

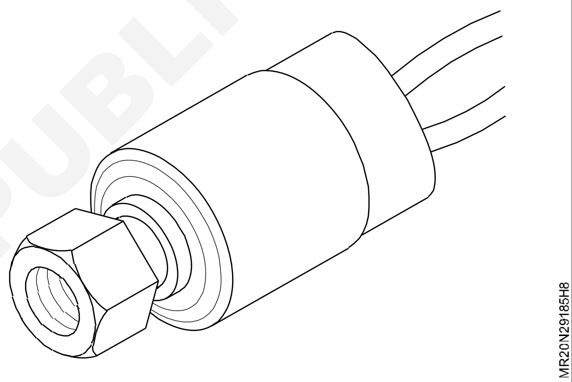
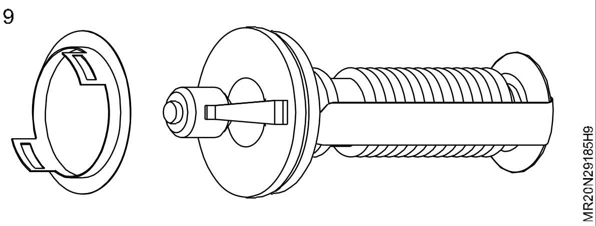


Fig 9



- **Identification of HP/LP (safety) cutout and parts of evaporator (cooling unit) are explained in Ex.812 and 817 respectively.**
- **Refer workshop/instruction manual of the vehicle/auto AC system for exact details and specifications. The specification of components/parts may change accordingly to the make and model of the vehicle/auto AC system.**

Identify various electrical compound used in car A.C.

1 Battery

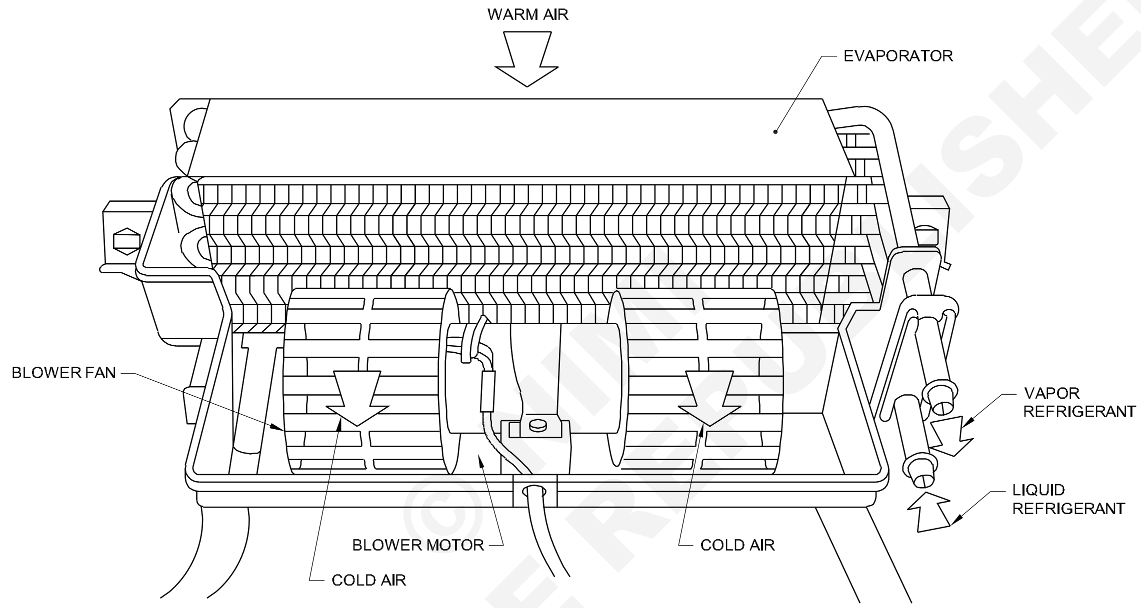
Fig 1

- Negative terminal connected to the ground.
- Positive terminal connected to ignition switch, cooling from relay and AC relay.

2 Blower motor

Connected between ignition switch and blower switch.

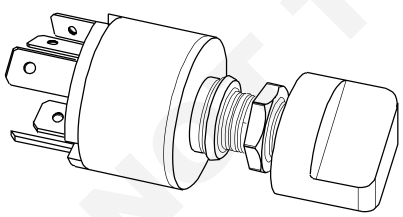
Fig 2



3 Blower switch

Connected between AC relay, AC switch and blower motor.

Fig 3

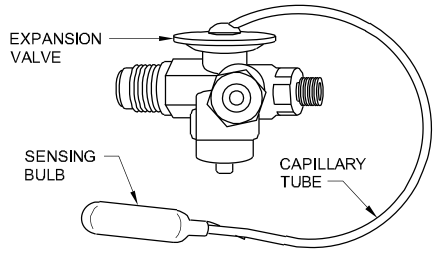


BLOWER SWTICH

4 Thermostat Expansion valve

Connected between AC switch and cooling fan relay.

Fig 4

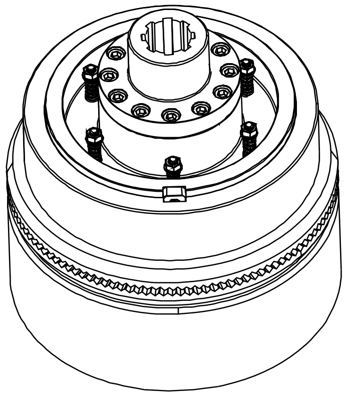


THERMOSTATIC EXPANSION VALVE

5 Electromagnetic clutch

Connected between high pressure switch and earth

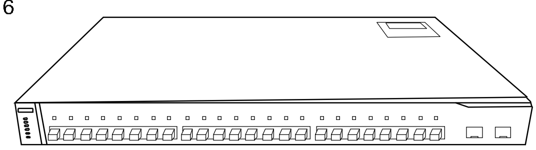
Fig 5



6 HP switch

Connected between compressor clutch and water temp cut relay.

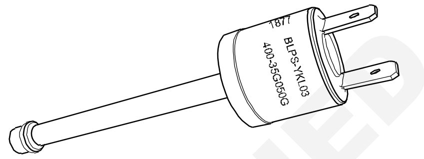
Fig 6



7 LP-switch

Will be connected between magnetic clutch and water cut relay in same cars.

Fig 7



Testing of system components & fault finding

Objectives: At the end of this exercise you shall be able to
- **testing car A/C system**
- **testing the performance of a car A/C system in a car.**

Requirements

Tools/Equipments

- Car A/C system - 1 No.
- Manifold gauge - 1 No.
- Socket - 1 No.
- Ratchet - 1 No.
- Clutch disk holder - 1 No.
- External circlip plier - 1 No.
- Thermometer (Dry bulb) - 1 No.
- Psychrometer (Dry and wet bulbs) - 1 No.
- Psychrometric chart - 1 No.
- 3 leg puller - 1 No.
- Press - 1 No.
- Screw driver - 1 No.

Materials

- Clutch bearing - 1 No.

PROCEDURE

TASK 1: **Check car A/C system**

1 Connect the manifold gauge to the A/C system in a car.

2 Keep all windows and door open.

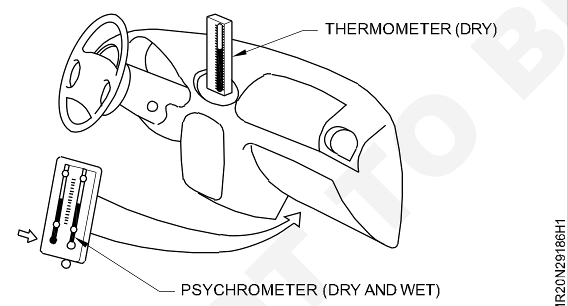
3 Run the engine at 2000 RPM.

4 Set the controls for maximum cooling.

5 Keep the blower at high speed.

6 Keep a dry bulb thermometer in the cool air outlet. (Fig 1)

Fig 1



7 Place a psychrometer close to the inlet of the cooling unit.

8 Check the high pressure gauge reading (200 to 230 psi). If the reading is too high, pour water on the condenser, if the reading is too low, cover the front of the condenser.

9 Check that the reading on the dry bulb thermometer at the air inlet at 25-35°C.

10 Calculate the relative humidity from the psychrometric graph by comparing the wet and dry bulb reading of the psychrometer at the air inlet.

— — — — — — — —

TASK 2: **A/C system performance**

1 Park vehicle out of direct sunlight.

2 Connect manifold gauge set.

3 Start and run engine at 1500 RPM.

4 Set A/C controls to MAX A/C and maximum cold setting.

5 Set blower/fan on high speed.

6 Close doors and windows.

7 Insert thermometer in center vent.

8 Operate system for 10 minutes to allow system to stabilize.

9 Measure center vent output temperature.

10 At 68°F (20°C) ambient temperature, high side pressures should be 100-200psi (7.0 - 14.1 kg/cm^2) low side pressures should be 24 - 46psi (1.7 - 3.2 kg/cm^2).

11 When A/C clutch disengages, low side pressure will increase and high side pressure should decrease.

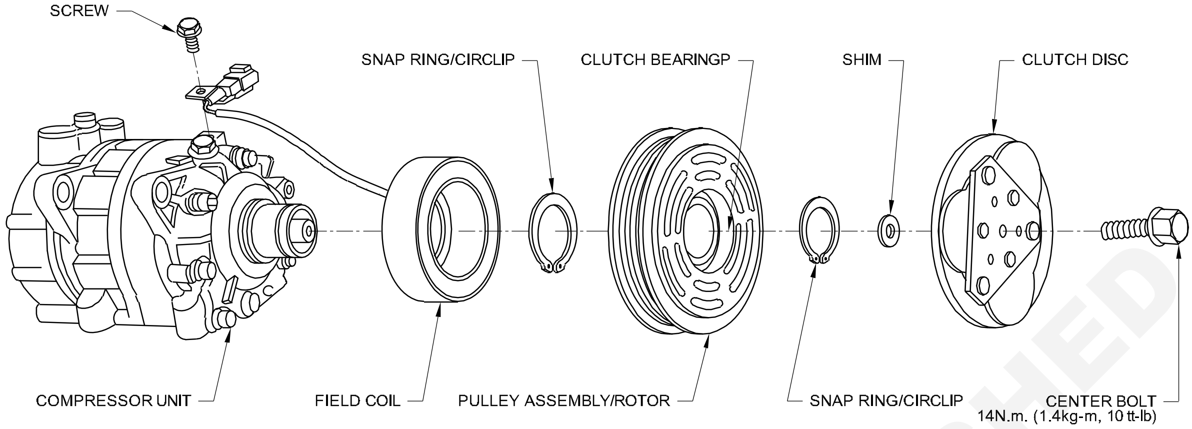
— — — — — — — —

Remove and replace clutch bearing

Objectives: At the end of this exercise you shall be able to
- **remove the clutch bearing**
- **replace the clutch hearing.**

TASK 1: **Remove centre bolt** (Fig 1)

Fig 1

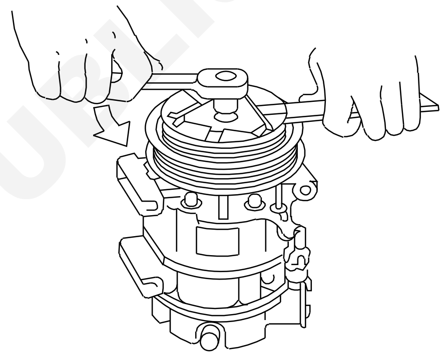


1 Hold clutch disc with clutch disc wrench.

2 Rotate the centre bolt as shown in the Fig 2. (Use correct socket and ratchet)

3 Remove the bolt carefully.

Fig 2



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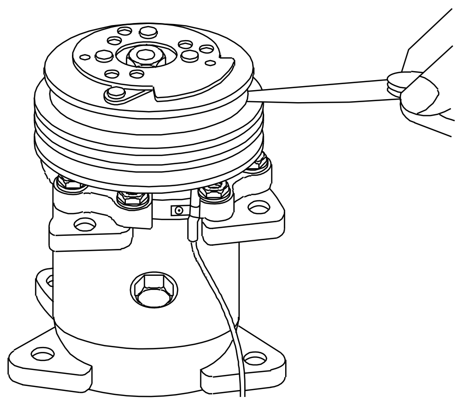
TASK 2: **Check and adjust the clutch clearance**

1 Using a feeler gauge check the clearance between the compressor drive pulley and the function plate, at several points around the pulley as shown in the Fig 1.

If the clearance is adjusted with shim, remove the function plate add or remove shims

For clearance refer Workshop Manual.

Fig 1



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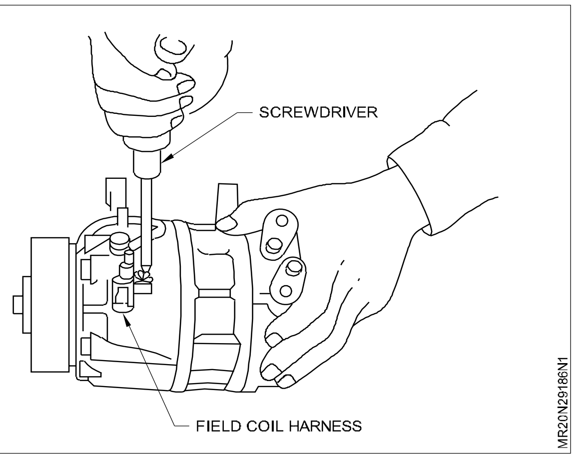
TASK 3: **Remove Harness clip**

Fig 1



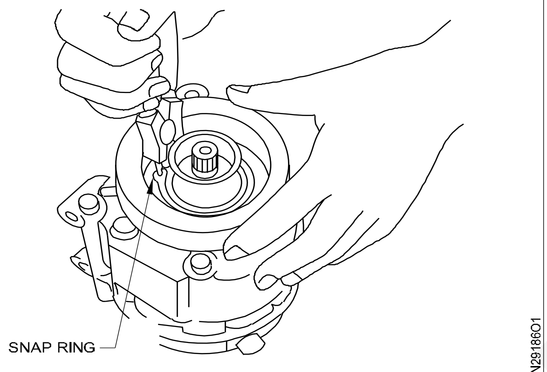
1 Remove the field coil harness clip using a screw driver.

2 Hold the compressor by left hand.

3 Hold the screw driver by the right hand and remove the harness clip carefully.

TASK 4: **Remove Circlip**

Fig 1



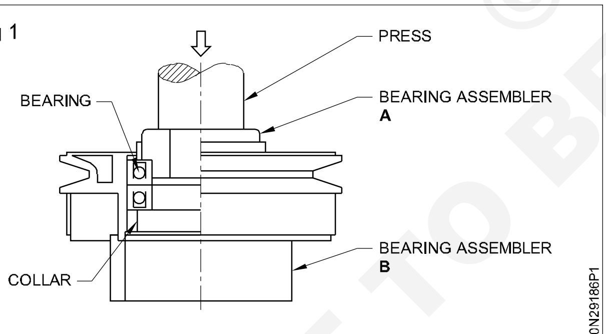
REMOVAL OF CIRCLIP

1 Remove the circlip use external circlip plier.

2 The operation process.

TASK 5: **Remove bearing**

Fig 1



BEARING REMOVAL

1 Place the motor on a bearing remover.

2 Press out the bearings and the collar.

3 Remove the bearing out carefully.

TASK 6: **Remove clutch disc**

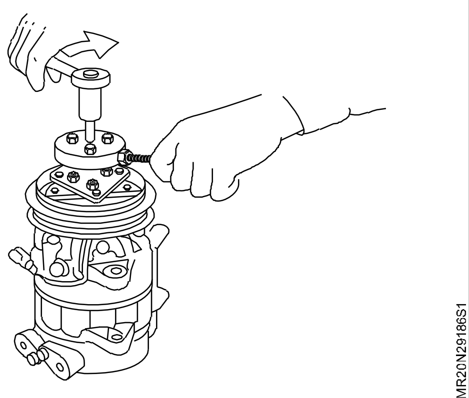
1 Insert the holders three pins into the holes in the clutch disc. (Fig 3)

2 Rotate the holder clockwise to hook i.e. on to the plate, then tighten the center bolt to remove the clutch disc.

After removing the clutch disc, remove the shims from either the drive side or the clutch disc.

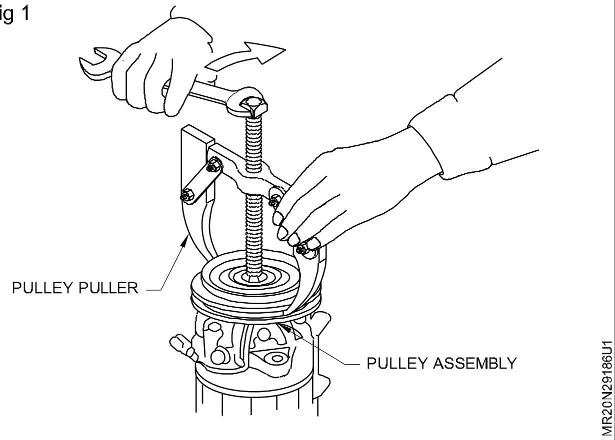
Cautions: Do not use screw drivers between clutch plate assembly and pulley to remove front plate. Doing so, may damage front plate assembly.

Fig 1



TASK 7: **Remove pulley**

Fig 1



1 Use the puller as shown in the picture. Position the center of the puller on the end of the drive shaft and remove the pulley assembly.

Cautions: To prevent the pulley groove from being deformed, the puller claws should not be positioned onto the edges of the pulley assembly.

Check and adjust thermostat switch

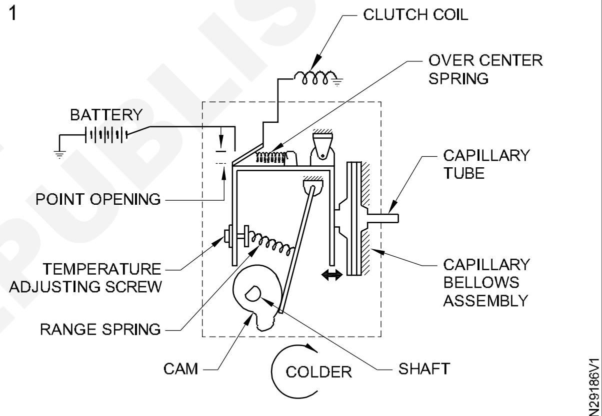
Objectives: At the end of this exercise you shall be able to
- **adjust the thermostat switch according to the requirement.**

1 Insert the screw driver in the groove of the adjusting screw as shown in the Fig 1.

2 Adjust the thermostatic switch by turning the screw clockwise/anti clockwise.

- **Do not force the screw at the time of adjustment.**
- **Some thermostat switches are not adjustable - Refer Workshop Manual.**

Fig 1



THERMOSTATIC SWITCH (OFF POSITION)

Check magnetic clutch

Objectives: At the end of this exercise you shall be able to
- **check the resistance of the field coil**
- **check the continuity between the clutch coil and its shell**
- **check the clearance and adjust.**

PROCEDURE

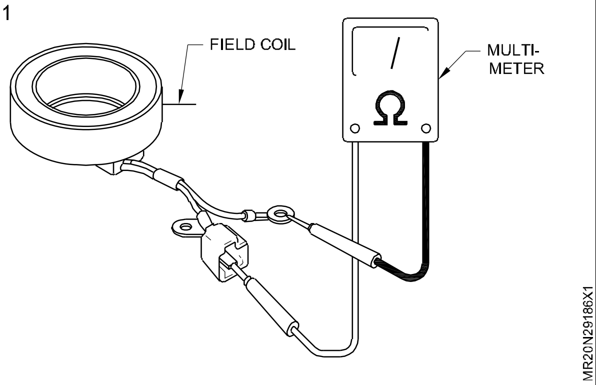
TASK 1: **Check the resistance of the field coil (Fig 1)**

1 Check the resistance across the coil lead wire and ground as shown in the Fig 1.

The specification is 3.4 - 3.8Ω at approximately 70°F (20°C) - Refer Workshop Manual.

If not within specification, replace clutch coil.

Fig 1

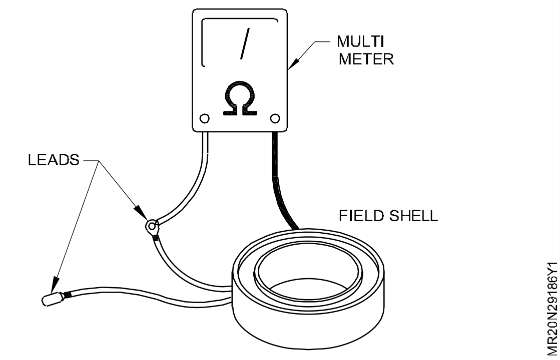


TASK 2: **Check the continuity between the clutch coil and its shell (Fig 2)**

1 Check for continuity between the clutch coil and its shell with the help of a multimeter as shown in the Fig 2.

> **There should not be any continuity. If there is, the coil's shorted internally replace it.**

Fig 1



Check and service receiver drier circuit

Objectives: At the end of this exercise you shall be able to
- **check whether the drier is defective or not.**

1 Connect the manifold gauge to the system.

2 Run the engine at 1500 RPM.

3 Switch On the A/C system (When the engine reaches the normal operating temperature).

> - **Bubbles (R-12) in sight glass.**
> - **Delivery temperature initially cold, then warm.**
> - **Cycles cold and warm as moisture freezes restricting the refrigerant freezes.**
> - **High pressure gauge rises as low pressure gauge decreases. (possibly into vacuum)**

> - **Bottom portion of the drier will not be but in the above condition.**

4 Check and confirm, if the system is affected anyone of above faults.

5 If yes, go to next step.

Corrective action

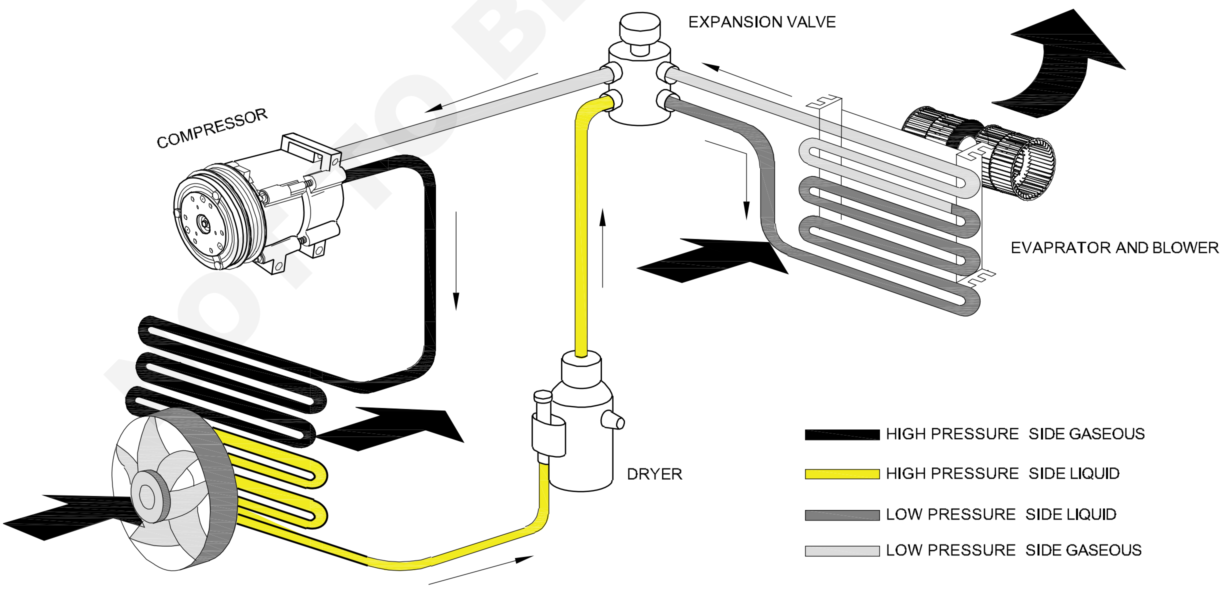
1 Evacuate the system.

2 Replace the drier.

3 Vacuum the system for an extended period (minimum 30 min.)

4 Charge the system.

Fig 1



Trouble shooting chart

Sl. No.	Probable defects	Cause/Reason	Remedial measure
1	Fuse blown	Continuity cut due to high current	Replace it
2	Wiring discontinuity	Damaged physically	Locate fault and reconnect
3	Clutch coil burnt	Aged/poor quality	Replace it
4	Thermostat contacts open	Loose connection	Replace it
5	Belt loose/cut	Wrong alignment/poor quality	Re-align/replace the belt
6	Compressor defective	Heavy load/poor quality of parts	Service/replace the compressor
7	Expansion valve open position/valve stuck	Valve damaged physically	Replace valve
8	Refrigerant line leak	Broken/damaged due to vibration	Repair the line and re-process the system
9	Refrigerant leak	Refrigerant lines damaged	Trace the leak spot, braze, re-process the system

Install gauge manifold to check suction and discharge pressure in charging time and running time

Objectives: At the end of this exercise you shall be able to
- **connect the manifold gauge to the system**
- **add dye to the system**
- **check refrigerant leakage in the system.**

Requirements

Tools/Equipments

- Manifold gauge set 1 Set.

Materials

- Copper tube 6mm OD - 150mm long 1 Piece.
- Refrigerant as reqd.
- Flare nuts brass 2 Nos.

The following procedure is for installing the car A/C system.

PROCEDURE

1 Connect the manifold gauge to the system.

2 Flush the system.

3 Remove the center hose from the manifold.

4 Replace it with a short piece (150mm long) 6mm Copper tubing using two 6mm flare nuts.

5 Connect one end of the gauge sets center hose to the dye solution.

6 Connect a can of refrigerant to the other end of the hose.

7 Operate the engine at fast idle speed.

8 Set the A/C system for maximum cooling.

9 Slowly open the low side hand valve to allow the dye solution to enter the system.

10 Charge system to atleast 50% capacity.

11 Operate the system for 15 minutes.

12 Shut off both A/C system and engine.

Check all connections, check the system again after 24 hrs. If leaks are found, repair as necessary.

Caution

- **To be used as internal leak detectors.**
- **Use of this type of solution may void.**
- **Some manufacture's warranties check with A/C system manufacturers.**

Charge the Refrigerant in car A/C system

Objectives: At the end of this exercise you shall be able to
- **charge the car A/C system with refrigerant to set the correct cooling.**

Caution: Never attempt to charge the system by opening the high gauge control while compressor is operating. The compressor accumulating pressure can burst the refrigerant container, causing severe personal injuries.

In this procedure the refrigerant enters the suction side of the system as a vapour while the compressor is running.

Before proceeding the system should be in partial vacuum after adequate evacuation.

Both hand valves on the manifold gauge should be closed.

1 Attach both test hoses to their respective service valve ports (refer Fig 1 for connection)

2 Attach center charging hose to the refrigerant - container valve. (refer Fig 2)

3 Open valve on the refrigerant can.

4 Loosen the center of the charging hose coupled where it connects to the gauge manifold to allow the escaping refrigerant to purge the hose contaminants.

5 Tighten the centre charging hose connection

6 Purge the low pressure test hose at the gauge manifold.

7 Start the engine, roll down the car windows and adjust the air conditioner to maximum cooling.

The car engine should be at normal operating temperature before proceeding. The heated environment helps the liquid vaporize more efficiently.

Fig 1

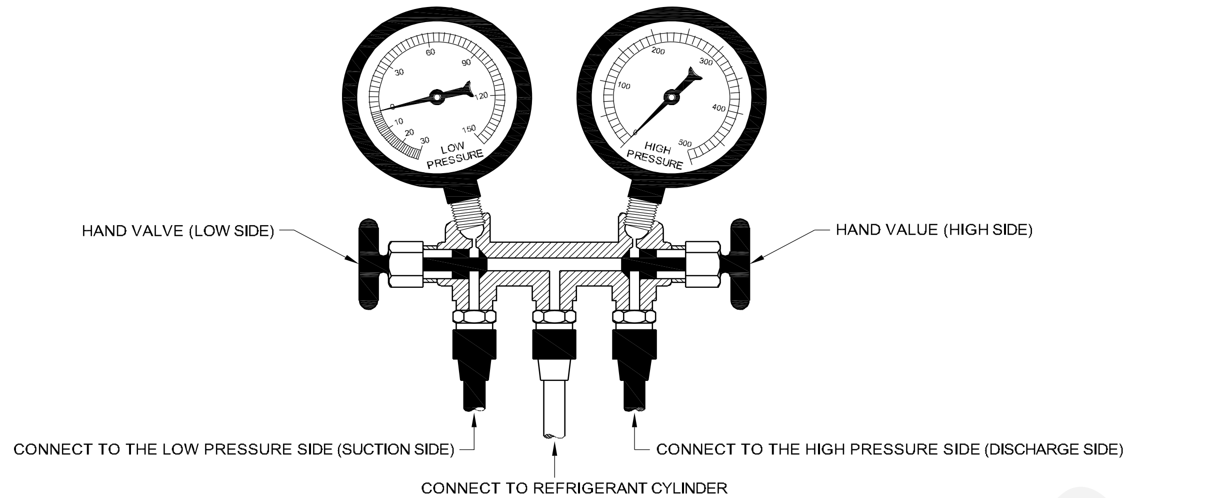
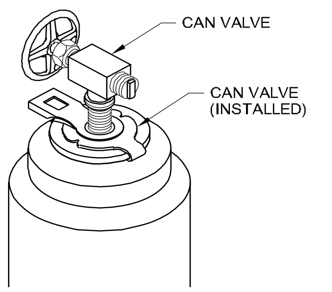


Fig 2



8 Open the low side hand valve on the manifold. Manipulate the valve so that the refrigerant that enters the system does not cause the low side pressure to exceed 30 psi (F-12).

Too sudden a surge may permit to rise the system may be overcharged or the engine might be overloading. Never allow heat pressure to go beyond 240 psi (F-12) during charging.

Purge air from the system

Objectives: At the end of this exercise you shall be able to
- **purge the A/C system.**

1 Connect the manifold as shown in the Fig.1.

Do not start the engine.

2 Vacuum the system

3 Close the low side and high side valves.

4 Remove the vacuum pump from centre hose (yellow colour hose)

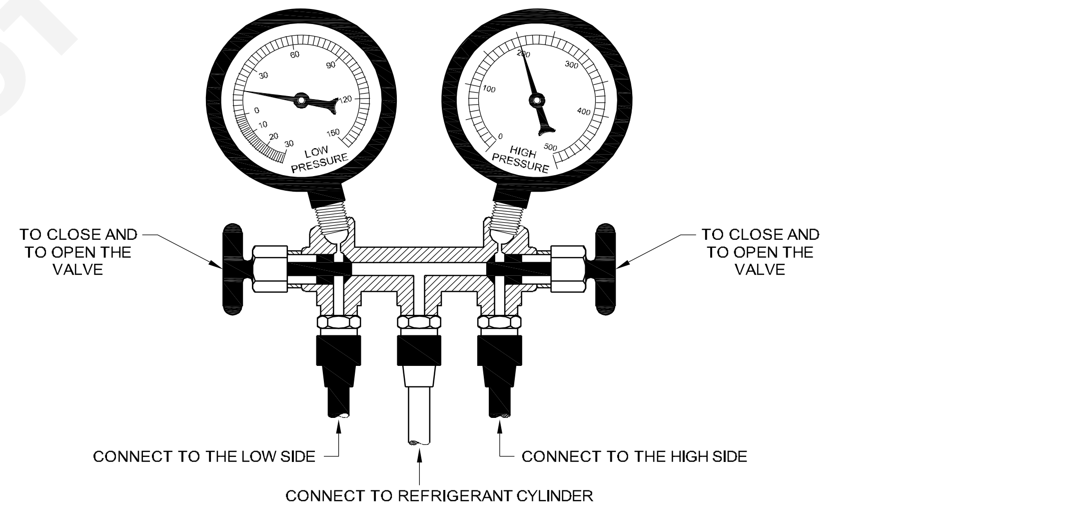
5 Connect refrigerant cylinder to the center hose (yellow colour hose)

6 Open the refrigerant valve (refrigerant will enter the centre hose)

7 Slowly open the centre hose (yellow) at point ‘A’ as shown in the Fig 1.

8 When a small amount of refrigerant escapes to the atmosphere close the hose immediately. (Air in the hose is removed). Now the system is ready for charge.

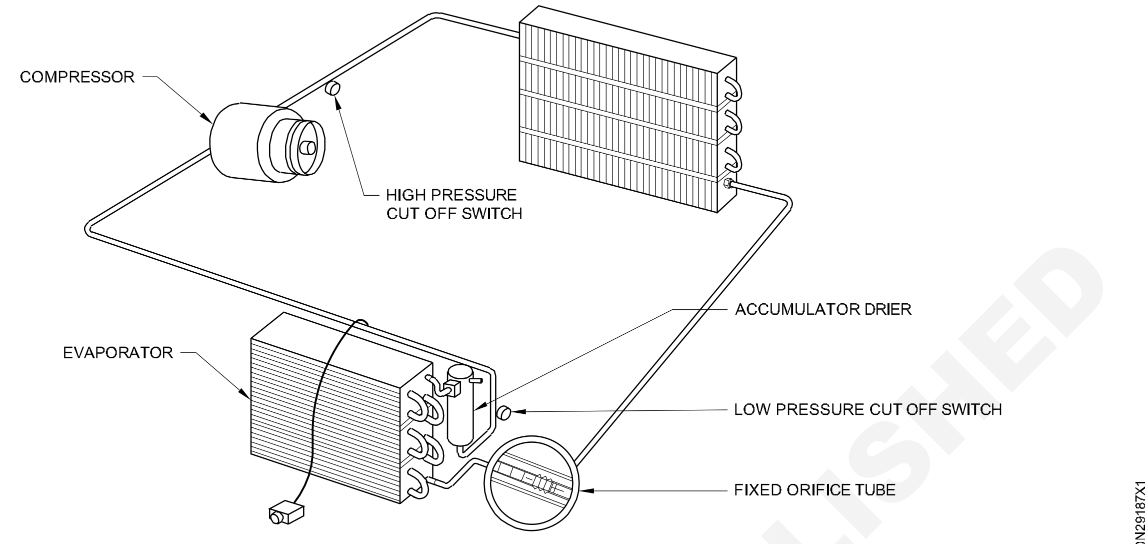
Fig 1



Identify, service and connect HP-LP switch

Objectives: At the end of this exercise you shall be able to
- **locate and identify the low pressure (LP) and high pressure switch (HP) in the system**
- **check the condition of LP and HP switches**
- **check the condition of low pressure switch.**

Fig 1



LOCATION OF LOW PRESSURE CUT OFF SWITCH IN THE SYSTEM

> **The Low Pressure switch (LP) is connected in series in the circuit.**
>
> **Low pressure switch cannot be repaired, it should be replaced when found defective.**
>
> **The low pressure settings may vary between cars using the same basic system. Certain switch manufacturers have the cutoff pressure level stamped on the switch body.**

Locate and identify the low pressure/high pressure switches (Fig 1)

1 Observe the suction line of the system.

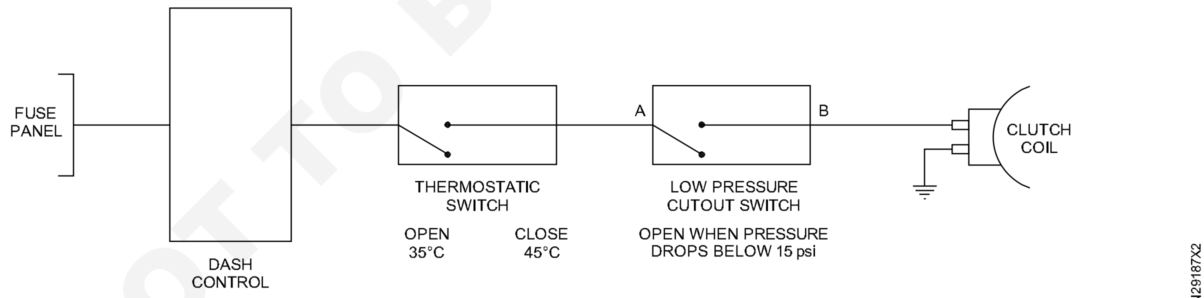
2 Identify the switch, which is located on the suction line.

3 Confirm the switch type.

4 Observe the discharge line of the system.

5 Identify the switch, which is located on the discharge line.

Fig 2



ELECTRICAL CONNECTION OF LOW PRESSURE CUTOUT SWITCH IN THE CIRCUIT

6 Confirm the switch-type.

Checking the condition of the low pressure switch

> **If the system is with low refrigerant, low pressure switch contacts will be open, the clutch will not engage.**
>
> **If the system is with refrigerant (refer workshop manual for pressure specification)**

1 Operate the A/C system

2 Check the input voltage and output voltage (Fig 2)

> **If there is no output voltage the switch is defective.**
>
> **If wire is connected between A & B the clutch should engage.**

— — — — — — — —

Leak testing using dry nitrogen evacuation gas charging oil charging (HFC-134a, HFO-1234yf and blends of HFCs and HFOs)

Objectives: At the end of this exercise you shall be able to
- **check the leakage in the A/C system**
- **recover refrigerant**
- **find out and rectify leakages**
- **evacuating the system**
- **charge the system with refrigerant**
- **performance checking**
- **add oil to compressor and system.**

Requirements

Tools/Instruments

- Double and spanner set - 1 No.
- Manifold gauge set - 1 Set.
- Vacuum pump/Recycle machine - 1 No each
- Recovery machine - 1 No.
- Electronic tester - 1 No.
- Two stage nitrogen pressure regulator - 1 No.
- Adaptor - 1 No.
- Refrigerant cylinder R-134a
- Recovery cylinder capacity 5 kg - 1 Set.
- Digital probe thermometer - 1 Set.
- Anemometer - 1 No.

Materials

- Refrigerant R-134 - as reqd.
- Refrigerant oil - as reqd.
- New thermostatic expansion valve
- Dry nitrogen filled cylinder
- PAG oil - as reqd.

PROCEDURE

TASK 1 : **Check the leakage in the AC system**

1 Run car at 1500 RPM.

2 Check all the joint with thick soap solution.

3 Check all the joint evaporator, condenser fins with Electronic leak detector.

— — — — — — — —

TASK 2 : **Recover refrigerant**

1 Disconnect negative cable from battery

2 Disconnect clutch lead wire from wiring hardness

3 Connect two flexible hoses from compressor service port to input of R & R Machine.(Recover and recycling machine)

4 Connect output with recovery cylinder putting on weighing machine.

5 Run recovery & recycling machine purge inlet cylinder hose and connect with cylinder.

6 Open recovery cylinder valve, check weight of cylinder how much recovered.

7 Close cylinder valve, when compound gauge shows negative pressure.

8 Switch off R & R machine, close all the valve of machine.

9 Disconnect flexible hoses from compressor service port & recovery cylinder.

— — — — — — — —

TASK 3 : **Find out and rectify leakages**

1 Connect hoses with service port and Nitrogen two stage regulator with dry nitrogen fill cylinder.

2 Open nitrogen cylinder valve and operate up to 150 P.S.I close regulator valve.

3 Check all the joint with thick soap solution, trace the spot and mark.

4 Open leakage joint observe position rectify and tight.

5 Fill dry nitrogen again check as previous method.

6 Release dry nitrogen slowly, loosing hoses nut

TASK 4 : **Evacuating the system**

1 Connect port hoses with Evacuation and charging unit.

2 Connect cylinder without open valve with Evacuation and Charging machine in put port.

3 Open all the valve knob of Evacuation & Charging unit.

4 When vacuum end-reached as our desired level 500 micron.

5 Close out let valve knob of machine, switch off the machine.

Vacuum hold for 10 minutes if vacuum not break perfect vacuum reached without leak.

— — — — — — — —

TASK 5 : **Charge the system with refrigerant**

1 Close all machine valve.

2 Put cylinder on weighing machine open cylinder valve.

3 Open in-let and high side valve knob of Evacuating charging unit.

4 Allow it to go in high side up to vacuum break, close high side knob and disconnect from discharge port.

5 Now open suction port valve knob allow remain refrigerant to go.

— — — — — — — —

TASK 6 : **Performance checking**

1 Connect the manifold gauge to the A/C system in a car.

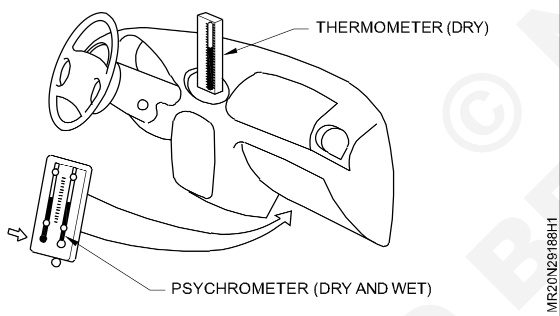
2 Keep all windows and door open.

3 Set the controls for maximum cooling.

4 Keep the blower at high speed.

5 Keep a dry bulb thermostat in the cool air outlet. (Fig 1)

Fig 1



6 Place a psychrometer close to the inlet of the cooling unit.

7 Check the high pressure gauge reading (200 to 230 psi).

8 Check that the reading on the dry bulb thermometer at the air inlet at 25-35°C.

9 Calculate the relative humidity from the psychrometer chart by comparing the wet and dry bulb reading.

10 Park vehicle out of direct sunlight.

11 Connect manifold gauge set. Low pressure 1-3 kg/cm^2 high press. 12-22 kg/cm^2

12 Start and run engine at 1500 rpm.

13 Set A/C controls to max A/C and maximum cold setting.

14 Set blower / fan on high speed.

15 Close doors and windows.

16 Insert thermometer in centre vent gill temperature 12.4°C.

17 Operate system for 10 minutes to allow system to stabilize.

18 Measure centre vent output temperature.

When A/C clutch disengages, low side pressure will increase and high side pressure should decrease.

19 Close the cap of service port after checking.

— — — — — — — —

TASK 7: **Add oil to the compressor and system adding oil to the compressor**

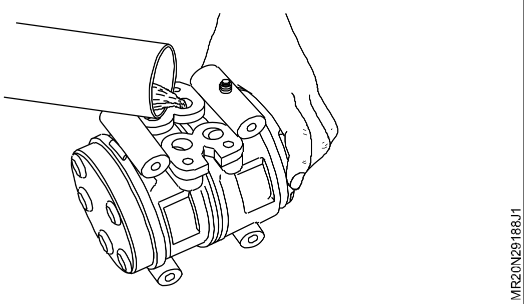
1 Discharge the system

2 Remove the compressor from the car

3 Draw oil by tilting the compressor slightly with care from the suction port.

4 Add refrigerant oil through compressor suction port to system capacity, minus the capacity of the components that have not been replaced. Refer Fig 1

Fig 1

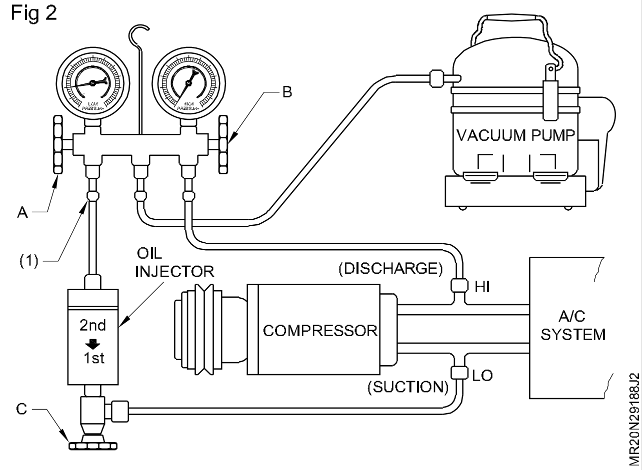


Refer the workshop manual for the system quantity and type of oil. (Too little oil will provide in adequate compressor lubrication and cause compressor failure. Too much oil will increase discharge air temperature).

Add oil to the system

1 Connect the oil injector in series with the low side test fitting and the low side gauge as shown in the Fig 3.

Fig 2



Engine should be off.

2 Turn ON the vacuum pump and open the high side shut off valve on the manifold (B)

3 Low side shut off valve on the manifold (A) should be closed.

4 Valve 'C' is closed

5 Add required amount of oil to the injector (50 cc)

6 Secure the injector cap

7 Start the vacuum pump

8 When the vacuum is 29" Hg or more open the injector valve 'C'.

9 Close the high side valve B and open the low side valve A. Oil will be drawn into the low side of the system. If more oil is needed, repeat the sequence.

Refer the workshop manual for the system quantity and type of oil.

Installation and trouble shooting

Objectives: At the end of this exercise you shall be able to
- **installation of bus A.C**
- **trouble shooting and remedies of bus A.C.**

Requirements

Tools/Instruments

- Screw driver - 1 No.
- Double ended spanner set - 1 Set.
- Ring spanner set - 1 Set.
- Hammer ball peen - 1 kg, 0.5kg.
- Portable drill machine - 1 No.
- Measuring tape 50 metre - 1 No.
- Sprit level 300mm - 1 No.
- Adjustable spanner 300mm - 1 No.

Equipment/Machines

- Car A/C kit - 1 No.

Materials

- Nut, bolt, screw - as reqd.
- Clean cloth - as reqd.
- Goggles - as reqd.
- Oil can - 1 Pair.
- Nitrogen cylinder, line with twoway regulator and gauges - 1 No.
- Rubber hose with jet arrangement thick soap solution - 1 No.

PROCEDURE

Installation for bus A/C

1 Find a suitable location to install compressor, condensor and liquid receiver.

2 Identify the pipe sittings between suction and discharge line as per the installation manual.

3 Install the unit with cooling coil with blower motor.

4 Connect the suction, discharge, liquid line, and cooling coil line by flaring nut properly.

5 Insulate the require place pipe line proper insulating material.

6 Operate and check the performance of the unit.

Trouble Shooting Chart

Symptoms	Probable Cause	Solution
Compressor does not work	Fuse or relay defective	Replace fuse or relay
	Magnetic clutch burned	Repair or replace clutch
	Compressor blocked	Repair or replace compressor
	Low pressure switch open	Lack of gas on system or defective low pressure switch
Low suction pressure	Lack of refrigerant	Check for leakage, fill to correct pressure amount
	Air return temperature is too low	Place the temperature sensor at the most appropriate position
	Dirty or defective expansion valve	Clean or replace the valve
	Evaporator motor is stopped	Replace motor
	Restriction in the system	Eliminate
	Loaded air filter	Clean or replace filter
	Dirty evaporator coil	Clean coil
High discharge pressure	Excess refrigerant in the system	Drain and capture refrigerant, fill to correct amount
	Refrigerant flow obstructed	Check for restriction (compressor valve blocked, filter dryer blocked, etc.)
	Condenser motor is stopped	Refer to sympton “Condenser motor is stopped”
	Dirty condenser coil	Clean and wash

AC does not cool down and the compressor remains on	Lack of refrigerant Air or other gas in the system Dirty or defective expansion valve Dirt evaporator coil Air filter dirty	Check the leakage, fill to correct amount Draw a vacuum (min.3h below 10mbar) replace filter dryer, remains on fill to correct amount Replace the valve Clean the valve Clean or replace filter
Cools down too much, compressor does not turn off	Incorrect temperature selection Temperature sensor badly placed	Adjust the temperature on the control panel Place the sensor appropriately
Condenser motor is stopped	Electric wiring connections with no contact Condenser motor is stopped Burned fuse or defective relay	Repair wiring harness Replace condenser motor Replace fuse/or relay
HP switch opens	Excessive refrigerant Condenser coil is dirty Condenser motor/motors stopped	Drain and collect excess refrigerant Clean the coil Replace motors
LP switch opens	Lack of refrigerant Dirty or defective expansion valve Dirty evaporator coil Excessively contaminated air filter Evaporator ventilator is stopped	Check for leakage, fill to correct amount Replace the valve Clean the coil Replace the filter Replace the evaporator fan

Testing magnetic clutch, Compressor overhauling, condenser cleaning and add refrigerant and regular maintenance

Objectives: At the end of this exercise you shall be able to
- **check magnetic clutch coil of automobile air conditioner**
- **replace magnetic clutch coil bearing of automobile air conditioner**
- **overhaul compressor**
- **clean the condenser**
- **testing wiring system**
- **add refrigerant.**

Requirements

Tools/Instruments

- Feeler gauge - 1 No.
- Multimeter - 1 No.
- Socket - 1 No.
- Ratchet - 1 No.
- Clutch disk holder - 1 No.
- External circlip plier - 1 No.
- 3 leg puller - 1 No.
- Press - 1 No.
- Screw driver - 1 No.

Materials

- SHIMS
- Magnetic clutch coil

PROCEDURE

TASK 1 : **Check magnetic clutch of automobile air conditioner**

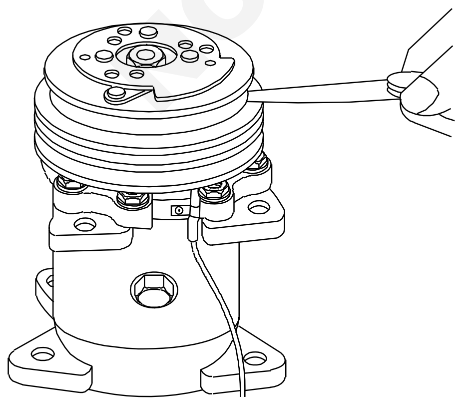
1 Check the resistance across the coil lead wire and ground as shown in the Figs 1 & 2.

[The specification is 3.4 - 3.8? at approximately 70°F (20°C) if not within specification, replace clutch coil. Refer workshop manual]

2 Check for continuity between the clutch coil and its shell with the help of a multimeter as shown in the (Fig 3) [if there should not be any continuity or coil shorted replace coil].

3 Check and adjust the clutch clearance using a feeler gauge check the clearance between the compressor drive pulley and the function plate, at several points around the pulley as shown in the Fig 1.

Fig 1



If the clearance is adjusted with shim, remove the function plate add or remove shims [For clearance refer workshop Manual]

Fig 2

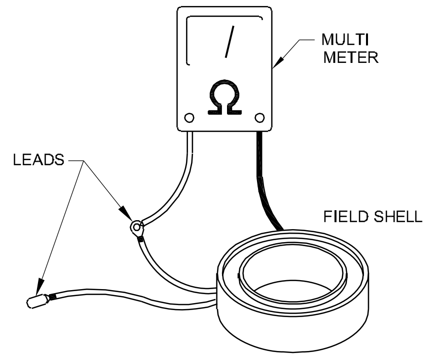
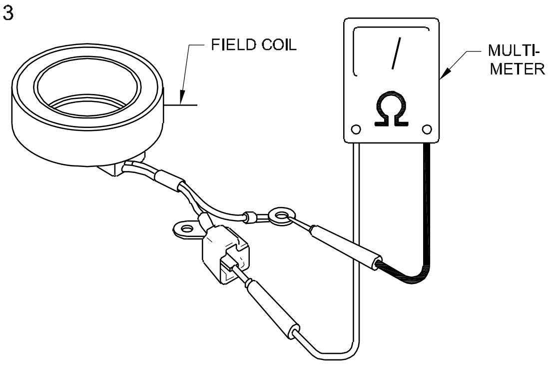


Fig 3



TASK 2 : **Check the working of magnetic clutch**

1 Open bonnet of vehicle.

2 Energised the magnetic clutch.

3 Check movement of armature plate. Check engagement by manually rotating pulley Fig 1

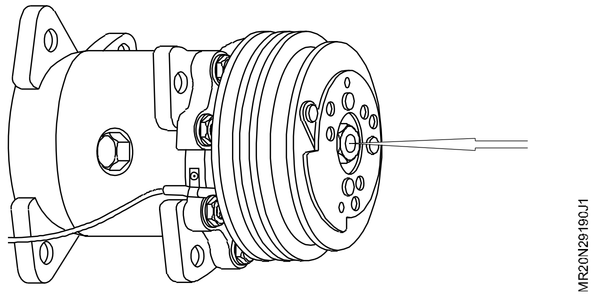
4 Start engine 1500 RPM at neutral position.

5 Place the motor on a bearing assembler.

6 Press in the bearing and collar.

7 Replace the bearing carefully.

Fig 1



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TASK 3 : **Replace magnetic clutch bearing of automobile air conditioner**

1 Remove centrebolt (Fig 1)

1a Hold clutch disc with clutch disc wrench.

1b Rotate the centre bolt as shown in the Fig 2. (Use correct socket and ratchet)

1c Remove the bolt carefully

Fig 1

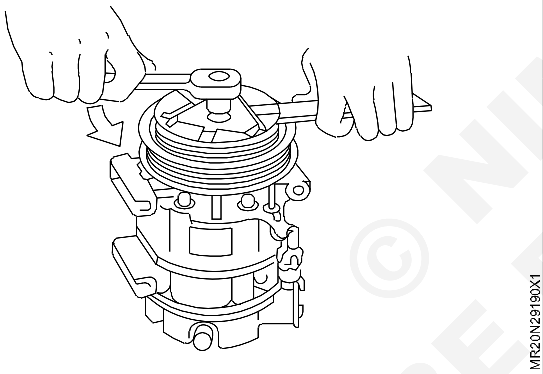
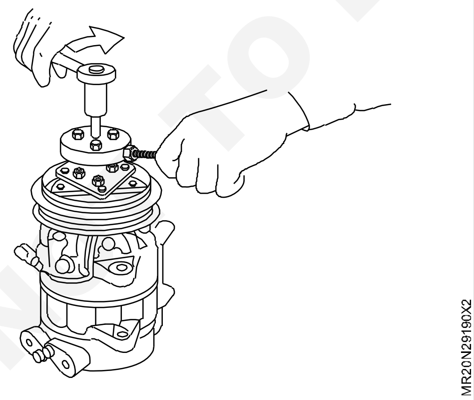


Fig 2

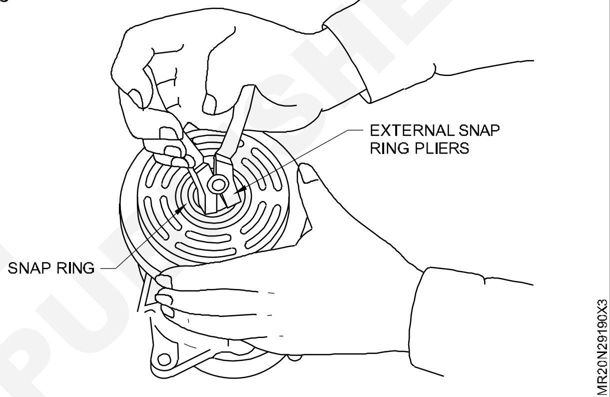


2 Remove Clutch disc

2a Insert the holders three pins into the holes in the clutch disc. (Fig 3)

2b Rotate the holder clockwise to hook i.e. on to the plate, then tighten the centre bolt to remove the clutch disc. After removing the clutch disc, remove the shims for either the drive side or the clutch disc.

Fig 3



Do not use screw drivers between clutch plate assembly and pulley to remove front plate. Doing so, may damage front plate assembly.

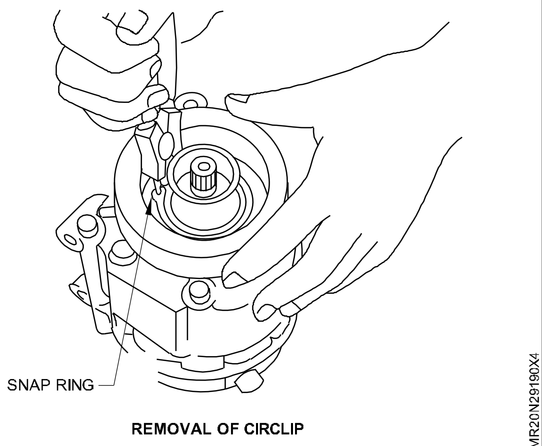
3 Remove circlip

3a Remove circlips using external circlip plier.

3b Refer Fig 4 for the operation.

3c Remove the circlip carefully.

Fig 4



4 Remove pulley

4a Use the puller as shown in the Fig 5 Position the centre of the puller on the end of the drive shaft and remove the pulley assembly.

To prevent the pulley groove from being deformed, the puller claws should not be positioned onto the edges of the pulley assembly.

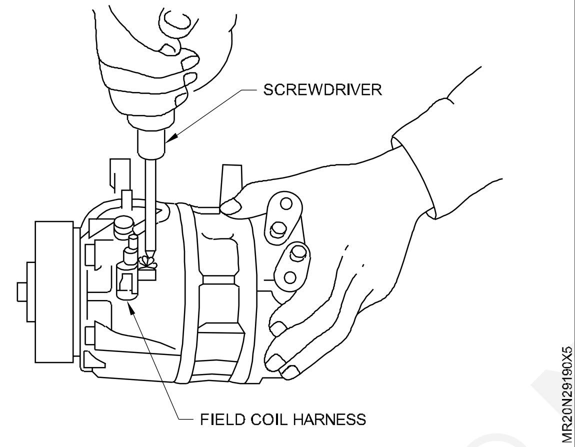
5 Remove Harness clip

5a Remove the field coil harness clip using a screw driver. (Refer Fig 5)

5b Hold the compressor by left hand.

5c Hold the screw driver by the right hand and remove the harness clip carefully.

Fig 5

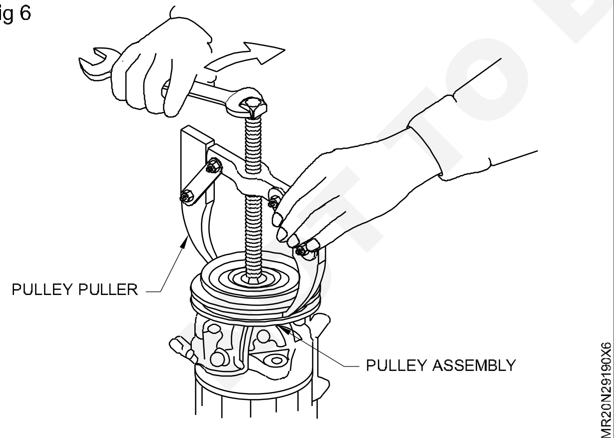


6 Remove circlip

6a Remove the circlip use external circlip plier.

6b Refer Fig 6 for the operation process.

Fig 6



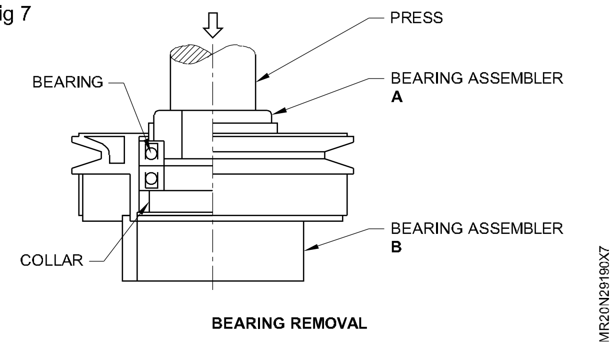
7 Remove bearing

7a Place the motor on a bearing remover. (Refer Fig 7)

7b Press out the bearings and the collar.

7c Remove the bearing out carefully.

Fig 7



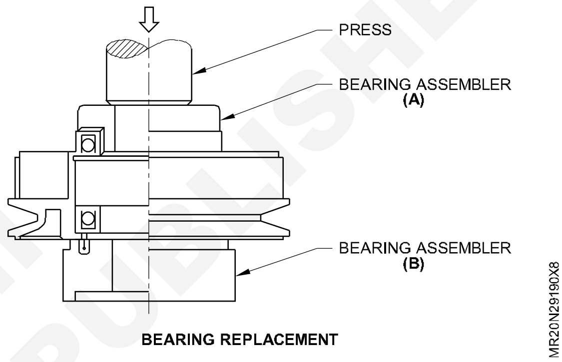
8 Replace bearing Fig 8.

8a Place the motor on a bearing assemble.

8b Press in the bearing and collar.

8c Replace the bearing carefully.

Fig 8

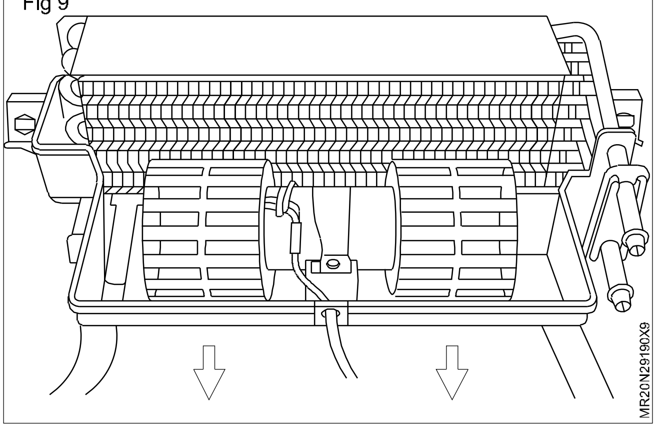


Clean the filter, evaporator and condenser

1 Remove the filter and clean with air pressure in the case of paper and blanket. Plastic nylon other clean by water.

2 Remove outer grill cover along with blower assembly. Fig 9

Fig 9



3 Clean evaporator with air blower.

4 Put polythene bag under evaporator to cover complete unit horizontally.

5 Spray dilute chemical on evaporator with spray bottle allow to dilute dust & dirt.

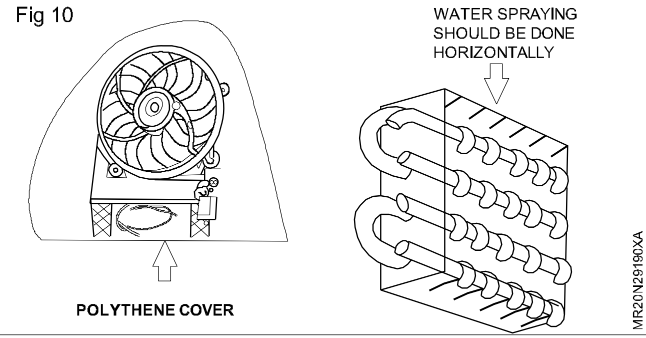
6 Spray clean water on evaporator.

7 Take out polythene bag and drain in waste pot again fit as previous.

8 Fit assembly and run all the inside water will deposited in polythene bag.

9 Cover condenser fan unit with polythene cover. Fig 10

Fig 10



10 Clean by forced air from inside towards outside.

11 Clean by forced water from inside towards outside. Fig 6

12 Blow compressed air horizontally with low pressure after water wash.

Water sprayer should move horizontally and not vertically water spraying will damage the fins of blower and condenser.

Check the system

1 Perform standard maintenance on the system clean evaporator, condenser, air filter. If any of the above are dirty it cause symtoms similar to a unit that is low on refrigerant.

2 Check for any obstruction, including buildup of debris on the air handler blower fan and make sure the condenser fan is operating correctly.

3 Conduct a through inspection of the rest of the components of the system. Like-Missing insulation, like ductwork joints, poor electrical connection etc.

Determine the need of the system

1 Determine the type of refrigerant need for the central A/C. Check the label on the unit's cabinet for manufacturer's specifications (R-22 or R410A).

2 Determine what type of charging connections your system is equipped with.

3 Start and stop the unit using the thermostat.

4 Turn the power off by removing the fuses or by turning the breaker off before continuing.

5 Hook up the gauge manifold with the unit when A/C unit is off. The blue hose to the low pressure side and red hose to the high pressure side.

6 Turn on the A/C and wait 15 minutes for the system to stabilize with the gauge being hooked up.

7 Take the reading on the gauges. The blue gauge should have dropped it the system needs to be charged.

8 Shut down the unit.

9 Attach the low pressure hose (blue) to the suction line and the high pressure hose (red) to the liquid line.

10 Turn on the AC. Let it run for at least 15 minutes so that the system can reach steady state operation.

11 Check the outdoor air temperature, return air temperature, suction line temperature and note it.

12 Determine the metering device used in the system. If the system uses a TEV or restrictor orifice.

13 Pump down the system and pressure test nitrogen (300psig) in the system with soap solution check leakage in the system. If leak is found arrest the leak. Evacuate the system.

14 Charge the system by connecting the charging or supply hose from manifold to the refrigerant container.

15 Check the parameters for proper cooling.

16 Connect a new cylinder with the system, if the parameters are not found specific and there is a need to add refrigerant.

17 Introduce refrigerant into the suction line of the system, slowly and in small amounts.

18 Check pressure and temperature readings and determine if more refrigerant

19 Repeat until every parameters as per specifications looks normal.

20 Observe a complete cooling cycle.

21 Turn off the power to the unit and remove the gauge, after AC has completed a cycle.

Note: Do not tilt the refrigerant container, as this will introduce liquid refrigerant into the suction side of the compressor and can result in damage to the unit.

Regular maintenance

1 Perform periodical maintenance of the bus A/C system according to the provided maintenance chart below.

Weekly

1 Clean or change the air return filter.

2 Inspect the general conditions, the tensioning and the alignment of the compressor and alternator belts.

Monthly

1 Perform the weekly preventive maintenance routines.

2 Clear the condenser coil. (use only mild soap and water, not abrasive to cooper and aluminum)

3 Check the evaporator hoods ensure to prevent the entry false air into the equipment.

4 Check the refrigerant gas load: After 15 minutes of operation the refrigerant must flow through sight glass without bubbles.

5 Check the compressor oil level: After 15 minutes of operation it must be between ¾ and ¼ of the sight glass.

6 Test the equipment functions: cooling mode/ventilation mode (high and low speed)/ heating/air refreshment.

Quarterly

1 Perform the monthly preventive maintenance routines.

2 Measure the suction and discharge pressure and check the temperature and condition of the suction line.

3 Tighten the alternator power cables, main fuse, relay plate and starter.

4 Measure the current consumption of the condenser fans and the evaporator blower (check the air flow).

5 Measure the magnetic resistance of the clutch.

6 Measure the voltage and current of the alternator.

Every six months

1 Perform the quarterly preventive maintenance routines.

2 Clean the evaporator coil (use only mild soap and water, not abrasive to cooper and aluminum)

3 Clean the evaporator drains.

4 Check the retention of oil felt of compressor sealing.

5 Visually check the air conditioner components to see whether they show signs of leaking refrigerant and oil.

6 Observe if there are parts loose, damaged, broken or showing signs of wear, rust deterioration and friction with the body.

Annual

1 Perform the six months preventive maintenance routines.

2 Test compressor efficiency at 1500 rpm.

3 Check the compressor oil pump pressure at 1000rpm.

4 Check the open and closure pressure of the high and low pressure switches.

5 Tighten all screws from the compressor support and the unit, observing the applied torques.

6 Remove dirt deposited on the components condenser, controller, relay plate, compressor, clutch, alternator.

Note: All preventive maintenance described above is considered for operating under normal conditions should the conditions be other than expected the frequency of actions must be more intense.

7 Repair the faulty components of the bus A/C system according to the failure diagnosis table which lists the possible malfunctions and symptoms and the remedial action to be taken to restore the system to its normal operation.

Compressor overhaule components

Objectives: At the end of this exercise you shall be able to
- **dismantle the compressor (swash plate type)**
- **identify the components of the dismantled compressor**
- **assemble and service the compressor.**

TASK 1 : **Identify the components of the dismantled compressor**

1 Remove the clutch mechanism Fig 1 (Ref Ex No:821)

2 Remove the through mounting bolts.

3 Gently tap rear housing with a wooden mallet.

4 Gently tap front housing with wooden mallet.

5 Take apart front and rear housing.

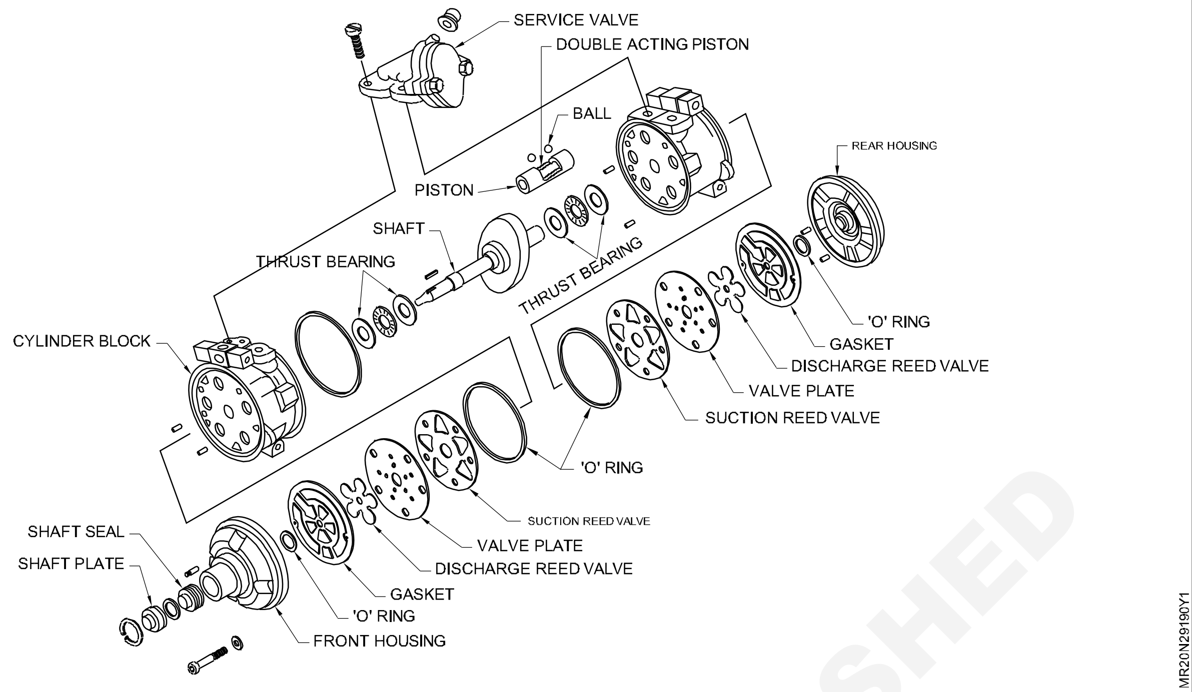
6 Remove gasket, discharge reed valve, plate.

7 Remove the service valve housing

8 Take cylinder blocks apart with gentle tap by the mallet.

9 Identify the parts and record.

Fig 1



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TASK 2 : **Assemble and service the compressor**

1 Clean the parts with a soft cloth.

2 Clean the parts also with the cleaning liquid- trichloro ethylene, whichever requires/found not clean.

3 Take the cylinder blocks together with gentle tap by the mallet.

4 Assemble the service valve housing.

5 Assemble gasket, discharge valve reed, valve plate together.

6 Take together front and rear housing.

7 Use wooden mallet for connecting together.

8 Put the mounting bolts.

Record sheet

Date :

Compressor make :

Model No :

Sl.No.	Name of the part	Physical condition	Physical dimensions (mm)	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Trainee **Instructor**

Testing wiring system

Objectives: At the end of this exercise you shall be able to
- **trace the wiring circuit of bus A/C**
- **connect the components mentioned in the circuit.**

PROCEDURE

TASK 1: **Trace the wiring circuit of bus A/C as per Fig 1**

> **Wiring diagrams are not hard to follow, once you understand the basic requirements of the electrical circuit and the symbols used in the diagrams, you can easily trace the circuit.**

Adding Refrigerant

1 Install manifold gauge at the in-line suction and discharge service ports.

2 Evacuate & dehydrate system.

3 Place cylinder on weighing machine. Prepare to charge liquid refrigerant by connecting charging hose from container to center connection on gauge manifold. Purge air from hoses.

4 Note weight of refrigerant cylinder.

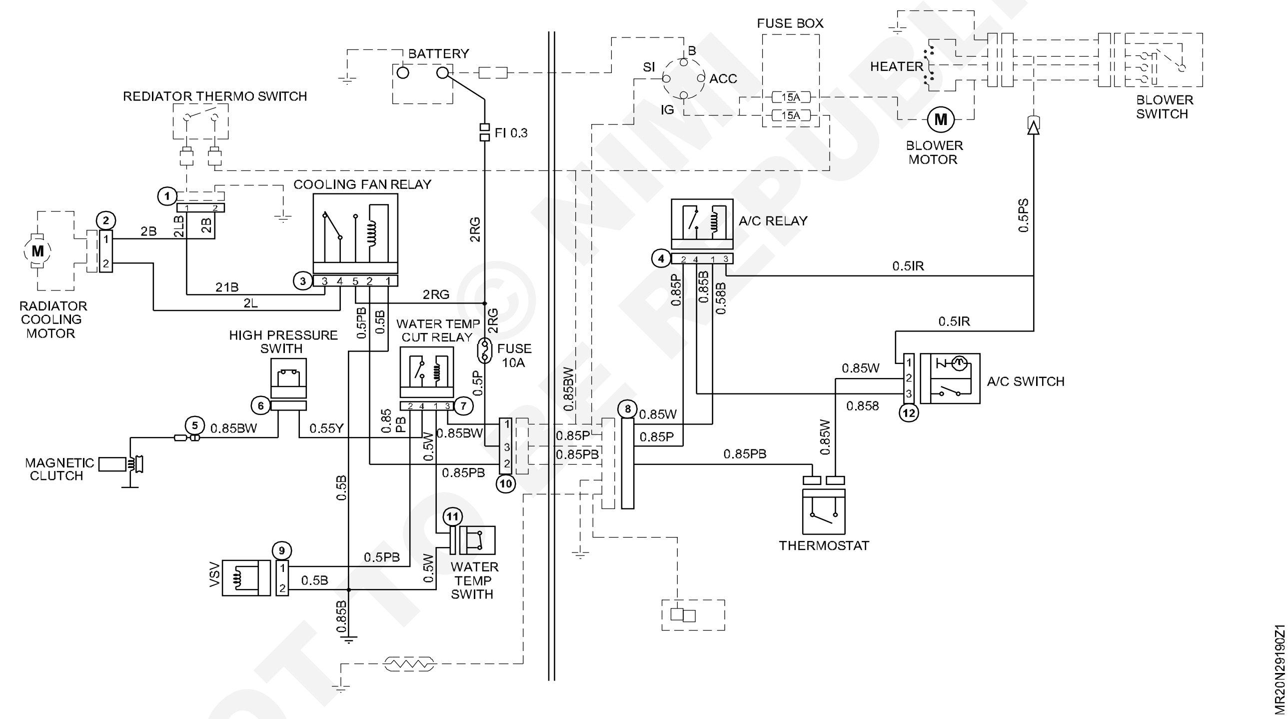
5 Open cylinder valve, backseat discharge valve on gauge manifold and allow liquid refrigerant to flow into the high side of system.

6 When correct charge has been added, close cylinder valve and frons eat manifold discharge valve.

7 Prepare the cylinder as required to allow vapor charging. Backseat the manifold suction valve and charge vapour until correct charge has been added close cylinder valve and front seat suction manifold set.

8 Check charge level.

Fig 1



TASK 2: **Connect the components mentioned in the circuit**

Battery

– Connect negative terminal to the ground.

– Connect positive terminal to ignition switch, cooling from relay and AC relay.

Blower motor: Connect blower motor between ignition switch and blower switch.

Blower switch: Connect blower switch, between AC relay, AC switch and blower motor.

Thermostat: Connect thermostat between AC switch and cooling fan relay.

Electromagnetic clutch: Connect electromagnetic clutch, between high pressure switch and earth.

HP switch: Connect HP switch, between compressor clutch and water temp cut relay.

LP-Switch: Connect LP switch between magnetic clutch and water cut relay in same cars.

Study/execute repair of different commercial units at site

Objectives: At the end of this exercise you shall be able to
- **execute the servicing of central A/C (Direct system)**
- **execute servicing of central A/C (Indirect system)**
- **maintain Log sheet.**

Requirements

Tools/Instruments

- Screw driver (150mm to 300mm) - 1 No each
- Combination plier - 1 No.
- Long nose plier - 1 No.
- Flat nose plier, Multimeter - 1 No.
- Anemometer - 1 No.
- Ratchet - 2 Nos.
- 3 leg puller - 1 No.
- Ring spanner set 8 to 32mm - 1 Set.
- DE spanner 8 to 32mm - 1 Set.
- Compound gauge - 1 No.
- Pressure gauge - 1 No.
- Charging hoses - 2 Nos.
- Dry N_2 cylinder with pressure regulating valve -1 No.
- Refrigerant cylinders (R-22, R-134a) - 1 Nos each.

Equipment/Machines

- 5TR central A/C plant switch
- 5TR package A/C plant with
- Train A/C system.

Materials

- Refrigeration lub oil - as reqd.
- Snip (straight and bent) - 1 No each.
- Banian cloth - 2 Nos.
- 6.0mm flared dummy - 2 Nos.
- 6.0mm union coupling - 2 Nos.
- Measuring tape (5mtr) - 1 No.

PROCEDURE

TASK 1: **Execute the servicing of central A/C (Direct type)**

a Stop the air-conditioning plant for seasonal shut-down

1 Stop the plant as every day routine stop procedure and AHU also-after getting clearance from your instructor.

2 Install a pressure gauge in the back seat port of the compressors suction service valve and crack the valve's back seat.

3 Close the liquid line shut off valve, which is located after the condenser.

4 Lower the setting of the systems temperature control, since the liquid line solenoid valve to be kept open during pump down.

5 Install a jumper wire across the terminals of the low pressure switch which is the refrigerant pressure control (RPC) switch.

6 Start the compressors and watch the suction pressure

7 Stop the compressor when the suction side gauge reading reduces to. 15 kg/cm^2 (a little positive pressure)

8 'Off' the compressor main switch and keep 'unit under maintenance' board near electrical panel.

9 Front seat the compressor discharge valve.

10 Stop the cooling tower fan & water circulating pumps.

11 Remove the jumper wire from the low pressure control.

12 Check the condenser and liquid receiver (if provided) for refrigerant leak.

13 Remove the gauge from the port of the suction valve replace port plug and front seat the valve.

14 Close the supply & return water connections of the water cooled condenser.

15 Drain the cooling tower sump for cooling tower maintenance.

16 Attend the other shut-down jobs, which planed earlier, perform all annul maintenance of the AHU and other related auxiliary equipments.

b Start the A/C plant after shut down jobs are over

1 Check compressor oil level, when compressor is idle, the level should be around 60% in the sight glass.

2 While running check the oil level at 30 minutes equal intervals. When the load is uniform and high, if the level is lower than 40%, change oil.

3 Stop the compressor and check the shaft seal for oil leakage. If oil trace is found, check the seal for refrigerant leak with halide torch.

4 Check the condition of the air-filters of the air-handling unit, clean or replace filters as necessary.

5 Check the general operating conditions, system's refrigerants pressures and temperatures, etc.

6 Check throughout the week's log, if find any abnormalities take remedial action.

c Pump down the compressor

Ensure the plant is idle, if it is running, with the instruction of instructor.

1 Put off the system.

2 Close the suction (service) isolating valve.

3 Bypass the electrical connection at low pressure cutout switch.

4 Start the compressor drive motor.

5 Watch and wait till the suction pressure drops to 0.5 kg./sq.cm.

6 Stop the compressor-drive motor

7 Immediately close the delivery (discharge) valve.

8 Open the suction gauge port and vent the least gas pressure from the compressor.

Precaution: Do not allow the compressor suction pressure drop to vacuum, or allow oil to pump to the system.

d Pump down the system

1 Put off system, if it is running.

2 Bypass the electrical connection at the low pressure cutout switch.

3 Close the (king valve) liquid line shut off valve.

4 Start the compressor and watch the suction valve gauge pressure drops till 0.5 kg/sq.cm.

5 Stop the compressor and close the discharge valve. Transferring refrigerant to the receiver.

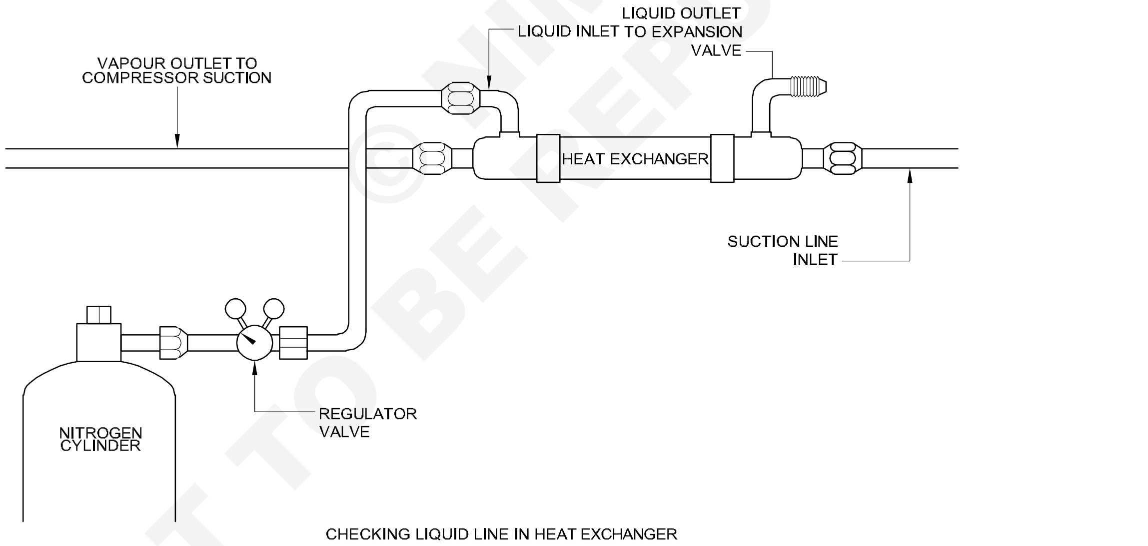
e Check the condition of the heat exchangers

1 When the plant is running, check and record the evaporator temperature.

2 Check and record liquid lines temperature, before and after heat exchanger.

3 Find the difference in temperature, if it is minimum, confirm the heat exchanger need service. For the location of heat exchanger.

Fig 1



CHECKING LIQUID LINE IN HEAT EXCHANGER

f Check compressor (Fig 2)

1 Check fitting of compressor.

2 Fit high pressure gauge on discharge point energised and check pressure as per compressor data.

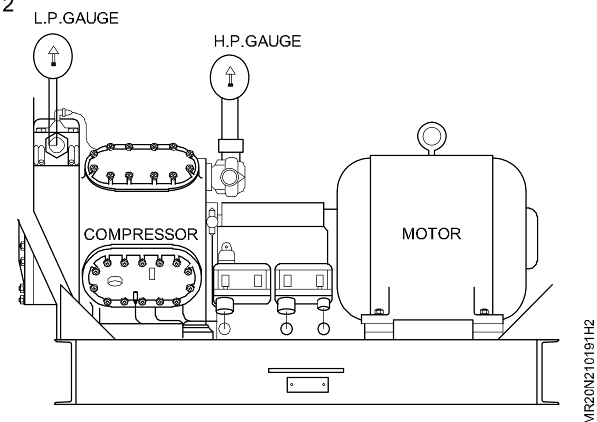
3 Fit low pressure gauge on suction point and check pressure as per compressor data.

4 Check ampere drawn as per data sheet.

g Check ducting

1 Check the AHU connecting duct is having noise or not.

Fig 2



2 Check whether the duct is having insulation or not, if found any area is un-insulated, insulate the area.

3 Check the canvas is damaged or not, if so replace the same.

4 Check the fire dampers, mixed dampers and by pass dampers and if faults is found, take necessary rectifying steps.

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TASK 2 : **Execute the servicing of central A/C (Indirect type)**

a Check the dry type shell and the evaporator (Fig1)

1 Connect the nitrogen line to the inlet of the tube side, close the refrigerant outlet with dummy flange.

> **Since the evaporator is used with R-22 gas, build up the pressure up to 6 kg/cm2 (50 percent more than the operating pressure of the suction line.**

2 Hold it for one hour, if there is no pressure drop, confirm the tubes are perfect.

3 Close the N2 cylinder valve, wear goggles and slowly open the dummy and release the nitrogen pressure inside the tube and remove the N2 cylinder and connections.

4 Check the pressure of the evaporator shell side, fill the water in the shell through chilled water inlet, after closing the drain till the water stands overflowing through the outlet, then fix dummy flange and tighten it.

5 Connect the hydraulic hand pumps line to inlet water flange and the outlet should be closed with dummy flange.

6 Now pump it, till the pressure raises to 6 kg/cm2. (50 percent higher than the chilled water operating pressure).

7 Hold the pressure for one hour and check, if there is no pressure drop in the gauge, confirm the shell side also perfectly leak proof.

b De-scale the condenser tube side (inner)

1 Put off the compressor and main power supply. Close the cooling water outlet and inlet valve.

2 Drain the water from the condenser through drain plug.

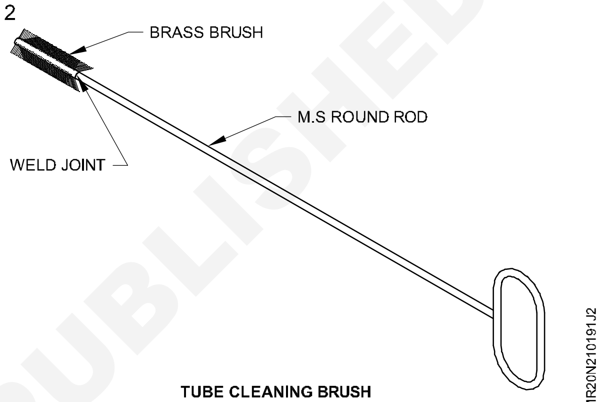
3 Punch mark the end cover with reference to tube sheet outer.

4 Loosen the water line flange and end covers retaining bolts.

5 Remove the end cover. Do not damage the gasket.

6 Clean each tube thoroughly with a soft brass tube cleaning brush which is welded to the rod. (Fig 2).

Fig 2



TUBE CLEANING BRUSH

c Check the pipe line leak and choose the method applicable to arrest the leak

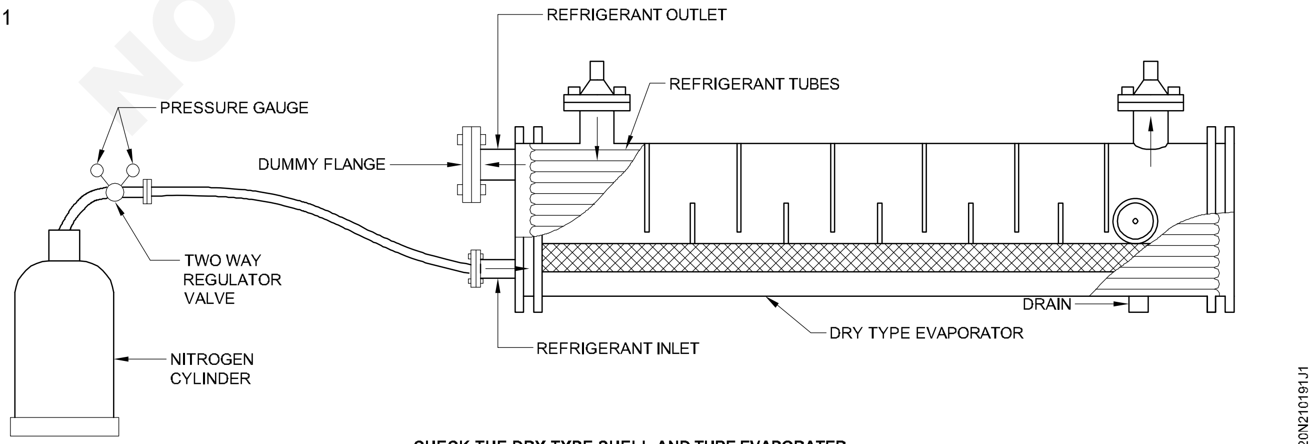
1 Trace out the water lines and see if there is any water leak or puncture on water lines.

2 Determine the leaks that can be arrested by plugging method, without stopping the water circulation pump.

3 Check for the leaks in the flange joints, that can be arrested by tightening the nuts or replace the gasket in downtime.

4 Choose the leak holes that can be covered with rubber gasket or pad, tightened by clamps, on line process.

Fig 1



CHECK THE DRY TYPE SHELL AND TUBE EVAPORATER

5 Check for the heavy leaks that need patch plate welding. That can be done at shutdown time.

6 Check if the pipes are corroded and many puncture or holes in short distance between the flanges, it can be replaced with a new pipe-when the plant is in shutdown.

d Arrest the water line leak-on line, leak arresting by wooden plug

1 Check and mark the spots where chilled water is leaking in pipe lines, and the leaks by the valves joints.

Get clearance from your superior or instructor for plant shutdown, then stop the plant.

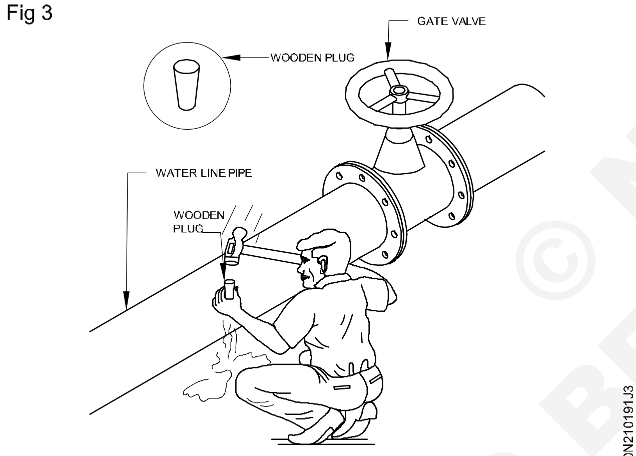
2 Mark the chilled water leakage.

3 Clear the waste insulation materials from that place and clean that leaking spots.

4 Identify the puncture holes size, make a wooden taper plug, suitable to the hole.

5 Place the taper wooden plugs narrow end in the pipe's hole and tap it gently with hammer. (Fig 3)

Fig 3



LEAK ARRESTING BY PLUGGING

6 Tap it till 3/4 of the length of the plug insert in tight, and leave the 1/4 portion length to be visible on top.

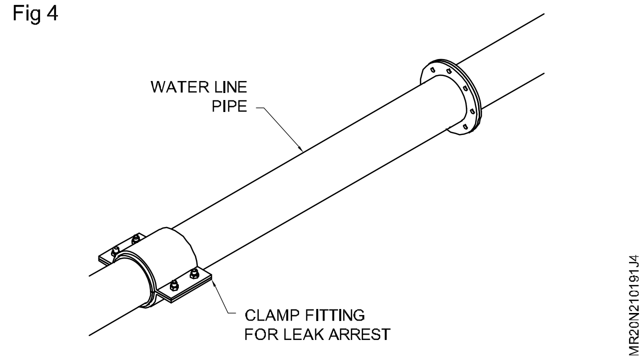
7 Check the water leak is arrested or minimised (Remember, these kind of leak arresting is in emergency, it should be covered with patch plate welding while the plant is shut down)

e Leak arresting by clamp fitting

1 Choose the suitable clamp and the rubber pad or gasket which will fit on the outer diameter of the leaking pipe.

2 Place the rubber pad on top of the leak and around the pipe, on top of the pad, set the clamp and tight it with bolts even either side. (Fig 4)

Fig 4



f Arrest the water line leak-while the pump is put 'off', leak arresting with 'm seal'

1 Mark the pin hole which is leaking by marking a circle by water proof marker on the pipe.

2 Close the water inlet valve, loosen the flange and drain the water inside the pump.

3 Clean the surrounding of the pin hole with emery sheet, remove the paint or rust on that particular place.

4 Mix the 'M' seal, apply on top of the puncture and press it tight.

5 Leave it to dry for minimum 8 hours; then tighten the flanges, and open the water line inlet valve.

6 Start the water circulating pump and check if the leak is arrested.

g Leak arresting by patch plate welding

1 Mark the leaking hole on the pipe.

2 After closing the water inlet valve, loosen the flange and drain the water inside the pipe line.

3 Clean the outer surface near the leaking spot.

4 Keep the suitable patch plate right on top of the hole and weld, all the four side of the plate firmly (Fig 5)

5 After welded portion become to normal temperature, open the water inlet valve.

6 Start the circulation pump and check the leak is arrested or not.

h To replace the faulty pipe line and arrest the leak

1 Remove the insulation from the flange joints and where you marked for leak spots.

2 Find the exact leak spot or puncture and clean that spot thoroughly.

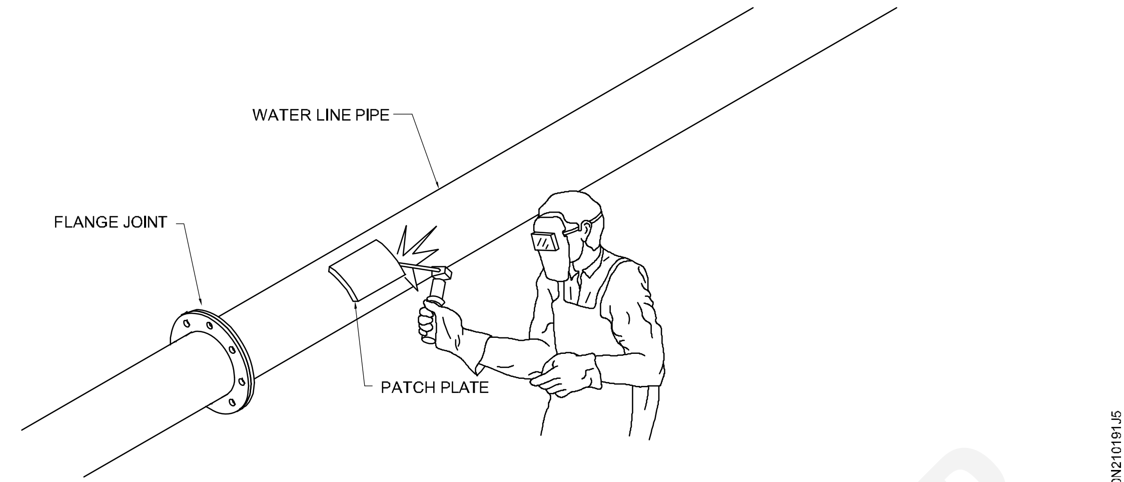
3 Open the end flanges and release remaining water.

4 Keep wet cloth, water bucket and fire extinguisher near.

5 Measure the damaged length of the pipe.

6 Mark and cut the old pipe and remove from coupling joint with adjustable pipe wrench.

Fig 5



PATCH PLATE WELDING ON THE PIPE LINE

7 Cut the new G.I. pipe according to the need (Required length) make thread on both the end of the pipe, and the cut end of existing old pipe line in position also make thread by thread dye.

i Rectify insulation faults

1 Check all over the chilled water pipes, valves and the storage tank, wherever the insulation are weak, mark it.

2 Replace the same with suitable insulation.

3 Where the thermocole is used, first apply liquid (hot) bitumen (melted by heat source) on the pipe's outer area, then fix the thermocole firmly as per the shape

4 Fill the air gaps in the joints of insulation with bitumen, then cover it with aluminium sheets and tighten it with self threaded screws. (Figs 4&5)

5 Wherever the mineral wool is packed for insulation, cover it with thin wire mesh and bind it water proof plastic sheet, then apply correct combination of cement paste leave it to dry.

6 After correcting all the leaks and insulation faults, open the water valves, vent the air (locks) by the pumps and the lines.

7 Start the chilled water pump and leave the water to circulate.

8 Finally once again check all over, for any leak, if there is no leak, start the plant and put in normal operation.

j Clean the cooling tower and rectify the problems in accessories

1 Open the cooling tower sump drain valve and empty it.

2 Remove the sludge in the bottom of the tank (with shovel and gather in bond) scrap and clean the algae thoroughly by G.I sheets.

3 Remove the water spray nozzles with suitable spanner, and clean it. Clean the spray holes, remove if there is any blockage then fit it.

4 Clean the louvers of the cooling tower by wire brush.

5 Replace the broken nozzles or louvers which is in bad condition.

6 Check the make-up water float-valve assembly, if need service it and check the action is perfect.

7 Lift the cooling tower strainer (which is located at the tank water outlet to circulating pump inlet) and clean it with wire brush.

8 Open the water make-up valve and fill the sump with fresh water.

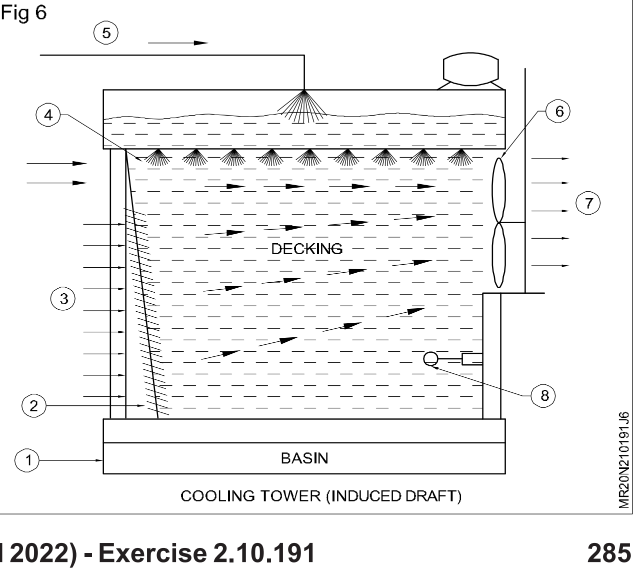
9 Start the water circulating pump and circulate the water for1 hour and stop it.

10 Drain the cooling tower sump once again.

11 Paint the non-corrosive (red-oxide) paint to supporting channels and ladder steps (M.S. metals) paint the pipes (water line) as per colour code.

12 Check and clean the drain and overflow pipe and fill the sump with fresh make-up water.

Fig 6



COOLING TOWER (INDUCED DRAFT)

13 Start the water circulating pumps and check the proper circulation of the cooling water.

14 Check the fan blades free rotation and start it, observe the operation of the cooling tower.

15 Start the unit after 1/2 an hour check and record all the parameters (Refer TASK 1 Procedure Step No.2 of this same exercise).

16 Enter the schedule maintenance completed date and find the temperature drop, improvement in cooling areas.

k) Clean and service air louvers

1 Check the condition of air louvers.

2 “Off” the air blower of AHU.

3 Remove airlouvers

4 Clean the air louvers by using high pressure water.

5 Dry the air louvers.

6 Fix back the air louvers.

7 “ON” the air blower motor of AHU.

Record sheet

Table 1

Present schedule maintenance completed date

Location	Pressure	Temperature
Compressor suction (Refrigerant vapour)		
Compressor discharge (Refrigerant vapour)		
(Warm) water, inlet of the cooling tower		
(Cooling) water, outlet of the cooling tower		

Table 2

Present schedule maintenance completed date

Location	Pressure	Temperature
Compressor suction (Refrigerant vapour)		
Compressor discharge (Refrigerant vapour)		
(Warm) water, inlet of the cooling tower		
(Cooling) water, outlet of the cooling tower		

$$\text{Cooling Towers efficiency} = \frac{\text{Range}}{\text{Range + Approach}} \times 100$$

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TASK 3: **Maintain log sheet for central A/C direct and indirect type**

1 Record the data obtained during servicing of central A/C in the below provided log sheet.

Record sheet

Table 1

Log sheet for plant room readings

DX or Chilled Water Plant

Time	Comp 1				Comp 2				Cond 1		Cond 2		Cond pump 1		Cond pump 2		CT Fan	Chiller 1		Chiller 2		CH.W pump1		CH.W pump 2	
									Press	Temp	Press	Temp	Press		Press			Press	Temp	Press	Temp	Press		Press	
	SP	DP	OP	Amps	SP	DP	OP	Amps	In out	In out	In out	In out	In out	Amps	In out	Amps	Amps	In out	In out	In out	In out	In out	Amps	In out	Amps

Table 2

	No.	Time started	Time stopped	Running hours
Compressor				
Condenser pump				
Cooling tower fan				
Chilled water pump				
Remarks			compressor total running hours	

Table 3

Log sheet for temperature readings

Air handling units

Date:																				
Time	AHU 1					AHU 2					Outside Temp			Inside Temp			Inside Temp			Remarks
	Canvas		Return			Canvas		Return												
	DB	WB	DB	WB	RH	DB	WB	DB	WB	RH	DB	WB	RH	DB	WB	RH	DB	WB	RH	

Remarks:

Trainee: **Instructor:**

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Study/execute preventive maintenance of different commercial units at site

Objectives: At the end of this exercise you shall be able to
- **perform preventive maintenance of central A/C (DX and Indirect)**
- **perform preventive maintenance of VRV/VRF**
- **perform the preventive maintenance of package A/C.**

Requirements

Tools/Instruments

• Wire brush	- 1 No.
• 50 mm brush	- 1 No.
• Screw driver 12"	- 1 No.
• Line tester	- 1 No.
• Pressure gauge 0 to 30 kg/cm2	- 1 No.
• Compound gauge	- 1 No.
• Charging hose	- 1 No.
• Screw spanner 12"	- 1 No.
• Digital thermometer	- 1 No.
• Tong tester	- 1 No.
• DE spanner set 4.7 mm to 16 mm	- 1 Set
and 19 mm to 31.8 mm	- 1 Set
• Valve key 6.4 mm sq	- 1 No.
• Tachometer digital	- 1 No.
• Allen key 5 mm	- 1 No.

Equipments

• Central A/C (5 TR)	- 1 No.
• Mobile A/C (Car mobile a/c,	
• bus mobile a/c, Train A/C)	- 1 No each.
• VRV/VRF	- 1 No.
• Vacuum cleaner	- 1 No.
• Air-blower	- 1 No.

Materials

• Clean cloth	- as reqd.
• Lubricating oil	- as reqd.
• Soap solution	- as reqd.
• Paint	- as reqd.

PROCEDURE

TASK 1: **Perform the preventive maintenance of central A/C**

a Weekly schedule

1 Remove filters from the case then

- Check & clean air filters by water & air blower
- Check water leak in water line, if it is found in flange joints, tight the bolt and nuts and arrest it, or change the gasket and arrest the leak.
- Check & clean water drainage system under cooling

2 Check safety controls

- L.P. cut out
- H.P. cut out
- Temperature control

3 Check temperature

- Check temperature with thermometer before the filter (return air temperature)
- Check blower outlet temperature

4 Check blower motor speed & shaft in play

- Check blower motor speed (RPM) with tachometer
- Check shaft in play physically

5 Check belt tension

- Stop the unit and check belt tension. If it is loose adjust the motor and correct it or replace the belt.

6 Canvas connection from unit to duct.

- Check any leak in canvas connection.
- Tight the screws and arrest the leak, if there is an ,leak in canvas clamps.
- Replace with new canvas if the old one is damaged.

7 Check condenser water pressure

- Check water pressure in condenser inlet and outlet.
- Adjust the water valves up to designed pressure, if the pressure is low or high.

8 Cooling tower

- Clean the filter (screen)

9 Water treatment

- Check cooling tower water quality

10 Check noise level/abnormal sound if any

- Tighten the bolts, screw tightly.
- Fit properly the front, back and side panels to avoid vibrating noise.

b De-scale the condenser tube side (inner)

1 Put off the compressor and main power supply. Close the cooling water outlet and inlet valve.

2 Drain the water from the condenser through drain plug.

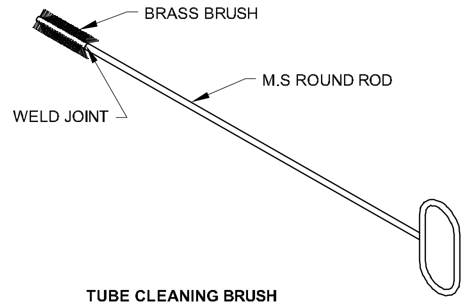
3 Punch mark the end cover with reference to tube sheet outer.

4 Loosen the water line flanges and end covers retaining bolts..

5 Remove the end cover. Do not damage the gasket.

6 Clean each tube thoroughly with a soft brass tube cleaning brush which is welded to the rod. (Fig 1)

Fig 1



TUBE CLEANING BRUSH

Caution

1 Do not use steel brush

2 Ensure that the welding joint from brush to rod is ground smooth and it should be of the rod dia.

3 After brushing each tube flush each tube individually with water immediately.

4 Check each tube after brushing if the scale is hard and the tube is cooled.

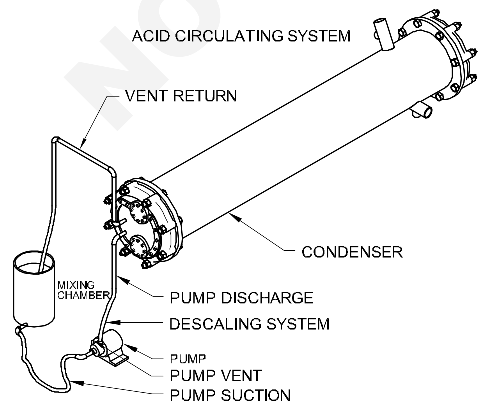
5 Then acid descaling to be carried out.

6 Fix both end covers and water line flanges with new gaskets to condenser.

7 Connect the acid circulating pump motor to power supply.

8 Connect the acid circulating system to the condenser as shown in Fig 2.

Fig 2



c Check and clean the air filters

1 Remove filter from the equipment.

2 Take the filter to open space and tap the filter to the ground (wear goggles and mouth mask).

3 Then take the filter to the washing area and rest against wall (inclined).

4 Fix flexible hose to water tap as shown in Fig 3.

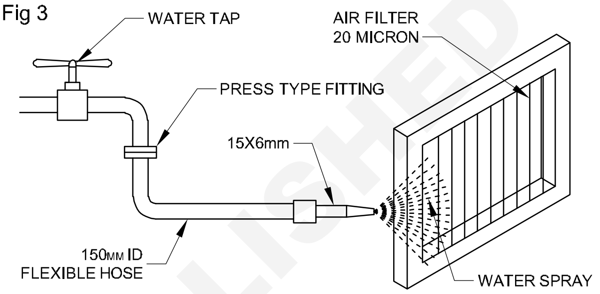
5 Open the tap & clean the filter with water.

6 Allow all the water to drain.

7 Fix the filter back its position.

8 Repeat this for all filters.

Fig 3



AIR FILTER CLEANING WITH WATER SPRAY

d Leak testing for refrigerant leak

1 Prepare soap solution.

2 Take piece of sponge, dip it in leathered soap solution.

3 Apply soap solution at all joints.

4 Observe leakage, if found arrest it.

5 For minute leakage use a halide torch for CFC system.

Precaution: Don't use soap solution at low side of the system

e Check water pump (packed) glands

1 Check water drip through the gland. It should be 8-10 drops/min.

2 If it is more, then tighten the glands nuts evenly.

3 If leakage is more then replace gland packing.

Precaution: The gland nuts should be evenly tightened to avoid the gland flange from touching the shaft.

4 Check and clean water strainer.

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TASK 2: **Perform preventive maintenance of VRV/VRF system.**

a Installation

1 Check that the unit is properly installed, the ODU is located in a suitable foundation, which can absorb vibration and can bear the weight of ODU.

2 Start up the unit and check for free circulation of air around ODU and IDU inside the conditioned area.

b Field wiring

1 Trace the wiring circuit of VRV/VRF from the installation manual.

2 Check the electrical and electronic components are tightly connected or not. Trace the wiring is ok or not.

c Power supply voltage: Check the power supply voltage on the supply panel by using digital multimeter and match with the identification label of the unit.

d Earth wiring: Check that the earth wires are connected properly and that the earth terminals are tightened.

e Insulation test of the main power circuit: Use a mega tester for 500v, check that the insulation resistance of 2mΩ or more is attained by applying a voltage of 500v DC between power terminals and earth.

> **Note: Never use the mega tester for transmission wiring.**

6 Fuses, circuit breakers, protection device: Check that the fuses, circuit breakers or the installed protection devices are of the size and type specified in the manual.

f Pipe size and pipe insulation: Check that correct pipe sizes are installed and that the insulation work is properly executed.

g Stop valves: Check that the stop valves are open on both liquid and gas side.

h Damaged equipment: Check the inside of the unit on damaged components or squeezed pipe.

i Refrigerant leak: Check the inside of the unit on refrigerant leakage. If there is a refrigerant leak, try to repair the leak.

j Oil leak: Check the compressor for oil leakage. If there is an oil leak, try to repair the leak.

k Air inlet/outlet: Check that the air inlet and outlet of the unit is not obstructed by any material.

l Additional refrigerant charge: Top up refrigerant if the system has run short off refrigerant.

m Various parameters: Check for DBT, WBT of return air and supply air and accordingly find the RH, specific volume, moisture content from the psychrometric chart.

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TASK 3: **Perform preventive maintenance of package A/C**

a Weekly schedule

1 Remove filters from the case then

- Check & clean air filters by water & air blower
- Check water leak in water line, if it is found in flange joints, tight the bolt and nuts and arrest it, or change the gasket and arrest the leak.
- Check & clean water drainage system under cooling

2 Check safety controls

- L.P. cut out
- H.P. cut out
- Temperature control

3 Check temperature

- Check temperature with thermometer before the filter (return air temperature)
- Check blower outlet temperature

4 Check blower motor speed & shaft in play

- Check blower motor speed (RPM) with tachometer
- Check shaft in play physically

5 Check belt tension

- Stop the unit and check belt tension. If it is loose adjust the motor and correct it or replace the belt.

6 Canvas connection from unit to duct.

- Check any leak in canvas connection.
- Tight the screws and arrest the leak, if there is an leak in canvas clamps.
- Replace with new canvas if the old one is damaged.

7 Check condenser water pressure

- Check water pressure in condenser inlet and outlet.
- Adjust the water valves up to designed pressure, if the pressure is low or high.

8 Cooling tower

- Clean the filter (screen)

9 Water treatment

- Check cooling tower water quality

10 Check noise level/abnormal sound if any

- Tighten the bolts, screw tightly.
- Fit properly the front, back and side panels to avoid vibrating noise.

b Monthly schedule

1 Check refrigerant leaks

- Check refrigerant leak in pipe joints and flare joints with application of soap solution.
- Apply soap solution at service valve cap and stem and check if there is any leak.

2 Check vibration

- Find out any vibration in the unit and check base bolts of the unit, compressor mounting bolts and blower motor bolts, for tightness.

3 Filters

- Remove the filter, clean it and fit it back.

4 Pressure check

- Check suction and discharge pressure.
- If the pressure is high purge non-condensable gas from the system.

5 Water valves operation

- Check water valve gland leak.
- If it leaks tight the gland nut.
- Check valve operation.
- Close and open the valve two or three times to make the operation easy.

c Quarterly schedule

1 Clean fan motor (cooling coil and cooling tower, air cooled condenser fan motor). Lubricate the fan motor. Paint the motor if necessary.

2 Check blower lock. If it is loose, tight it.

3 Clean water line strainer.

4 Check water circulating pump current, lubricate the pump bearings.

5 Check water flow switch.

6 Clean cooling tower spray nozzles.

d Yearly schedule

1 Condenser tube cleaning (descale water cooled condenser water tubes).

2 Air cooled condenser fins cleaning.

3 Evaporator fins cleaning with vacuum cleaner or air blower with brush.

4 Clean cooling tower / Service cooling water.

5 Paint water circulating pump, water lines, compressor, unit base, cooling tower fan motor, condenser shell and wherever necessary.

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